ATTACHMENT A

ED_013528_00000022-00002

ATTACHMENT B

TM 2.1 – Identification and Characterization of Potential Environmental Impacts Mitigation and Measures Related to Intake and Discharge Facilities of Seawater Desalination Plants

Variable Salinity Desalination Demonstration Project
City of Corpus Christi

10 July 2015

by

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Introduction

A preliminary overview of the potential environmental impacts and mitigation measures of several pre-determined sites as potential locations for intake and discharge facilities of seawater desalinization plants has been conducted. Below is a summary of those results. Also included in these analyses are matrices that further detail how the recommendations were derived, and there are lists of common species that would likely be impacted based on the current literature available. Certainly, as candidate site selection is conducted and refined, detailed assessments of species impacts as well as thorough site-specific analyses would need to be performed.

Intake Site Assessment

When considering locations for a desalinization intake site, multiple factors have to be examined. From an ecological standpoint, the biggest concerns are related to impacts that the desalination plant will have on the resident fauna. Two factors that have the most impact are impingement and entrainment. Impingement of larger fish, marine mammals, and sea turtles can reduce the spawning stock biomass due to an increased mortality rate. In addition, entrainment of smaller ichthyoplankton and eggs can reduce recruitment. Despite the known ecological impacts that construction of a desalinization plant creates, directed sampling pre- and post-construction is required in order to determine the actual environmental impacts to the selected site. While specific detailed mitigation measures are beyond the scope of this report, all sites with the exception of 2A and 2B (the most environmentally diverse locations) will likely have similar mitigation measures.

Specifically for this study, six candidate intake assessment locations were chosen by Freese and Nichols, Inc. The Harte Research Institute was contracted to identify potential environmental impacts of specific intake structures listed for the following locations: two chosen near Broadway WWTP, two near the La Quinta Channel Extension, one off-shore in the Gulf of Mexico, and one in the Viola Turning Basin in the Inner Harbor (Figure 1). In the following assessment, the key environmental intake topics of concern will be discussed:

- Impingement of marine life on screens
- Entrainment of marine life in desalinization plant
- Impacts on sea-grass and other sensitive marine areas
- Visual impacts and disturbance of coastal uses
- Impacts on coastal wetlands
- Other environmental issues

Overall Recommendations: This section summarizes our biological opinions on the proposed designs and locations, focusing on those that would minimize the impact to resident fauna and limit degradation or loss of high quality habitat. Under the current proposed plan, it is our biological opinion that the best intake type would be either the subsurface directional drilled or subsurface infiltration gallery intakes. Logistical limitations prevent all sites as candidates for these subsurface methods, and our recommendation considers these limitations. While benthic organisms will be impacted during the creation of the subsurface system, once created there is no freestanding source from which fauna could be impinged or entrained. When taking into account both the sites proposed and the intake types at those locations, we recommend a directional drilled intake at site 3A as the overall preferred location/intake type. Since the location is outside of Corpus Christi Bay, there will be less impact on ship navigation during construction. This site and intake type combination also will likely have the lowest overall effect on mortality (construction and daily operations). However, we do make alternative recommendations and provide our biological opinion on the pros and cons of each location. Overall, we recommend the following sites and intake type combinations (in order of preference):

1. Site 3A as a directional drilled intake
2. Site 3A as an infiltration gallery intake
3. Site 1A as a directional drilled intake
4. Site 1A as an infiltration gallery intake
5. Site 3A as a wedgewire intake
6. Site 1A as a wedgewire intake
7. Site 4A, onshore open intake
8. Site 1B, onshore open intake

9. Site 2A is not recommended for development due to significant environmental impacts
10. Site 2B is not recommended for development due to significant environmental impacts

<u>Site Specifics Recommendations</u>
The following is a site by site breakdown of the potential environmental impacts due to the construction of a desalinization intake. An intake selection matrix (Table 1) contains site-specific details and other criteria used to determine these recommendations. A list of the marine nekton species in Corpus Christi Bay has also been included (Table 2). Clearly, as facilities siting becomes more refined, detailed assessments will be needed to further elucidate site-specific impacts. These recommendations are presented by site number and not in order of preference.

Site 1: Near Broadway WWTP

Site 1A is located in the Corpus Christi Bay near Inner Harbor with submerged wedgewire, subsurface filtration gallery, or subsurface directional drilled intakes as the proposed types.

- **Impingement of marine life on screens**
  Constructing a submerged wedgewire intake would have a greater potential for impinging marine fauna as compared to a subsurface intake. A subsurface intake (either filtration gallery or directional drilled) would have the least amount of overall mortality since it does not protrude from the seafloor, so there is no concern of impingement for this type of intake.

- **Entrainment of marine life in desalinization plant**
  The wedgewire intake would have significantly higher marine life mortality on a daily operating basis as opposed to a subsurface intake. With a subsurface intake the water is drawn through the sand/gravel so most of the larvae and eggs in the water column will not filter through the seafloor and are not at risk for entrainment.

- **Impacts on seagrass and other sensitive marine areas**
  This location does not appear to have any type of limiting habitat (i.e., seagrasses) that would negatively impact the resident benthic fauna. If a subsurface intake was constructed it is possible that the motile species will be able to avoid the area during construction and potentially re-settle upon its completion.

- **Visual impacts and disturbance of coastal uses**
  Since it is submerged offshore, either of the intake options (wedgewire or submerged) present no concern regarding any type of visual or navigational disturbances upon completion.

- **Impacts on coastal wetlands**
  There are no concerns about coastal wetlands due to the intake being submerged and offshore.

- **Other environmental issues**
  No other environmental issues have currently been identified at this time.

Site 1B is located in the Corpus Christi Bay Turning Basin - proposed to be an onshore surface intake using traveling screens.

- **Impingement of marine life on screens**
  The onshore traveling screen intake will impact the surrounding marine fauna. Depending on construction location and depth, fish and invertebrates are likely to become impinged in the screen and occasional cleaning will be necessary to ensure proper operation. The use of fish buckets will help limit this problem, but there are still problems with macroalgae potentially fouling the screens.

- **Entrainment of marine life in plant**
  Larval fish, eggs, and plankton will be entrained in a traveling screen intake. However, the habitat quality in this area is likely already impacted by industrialization, so it is unlikely that the mortality from entrainment will be enough to substantially impact any local populations.

- **Impacts on seagrass and other sensitive marine areas**
  This location does not appear to have any type of sensitive habitat types (i.e., seagrasses) to an extent that would negatively impact the resident benthic fauna, so it is possible that the motile species will be able to avoid the area during construction and potentially re-settle upon completion.

- **Visual impacts and disturbance of coastal uses**
  As with all surface intakes, this unit (or building housing the unit) will be visible. Most of the area surrounding the proposed site is heavily industrialized so despite the construction of the new intake, the general aesthetics of the area will not change. One other consideration is the addition of any debris or sedimentation to

the barge canal during construction. A portion of the canal might need to be narrowed or closed, which could create problems for ships attempting to unload/load cargo in the surrounding area.

- **Impacts on coastal wetlands**
  While the shoreline will be impacted, there are no wetlands in the area proposed for intake placement so there is no potential for impacts on coastal wetlands.

- **Other environmental issues**
  No other environmental issues have currently been identified at this time.

Site 2: La Quinta Channel Extension

Site 2A is located west of Spoil Island with suggested intake types that include submerged infiltration gallery and submerged directional drilled.

- **Impingement of marine life on screens**
  No concerns due to submerged intakes.

- **Entrainment of marine life in plant**
  No concerns due to submerged intakes.

- **Impacts on seagrass and other sensitive marine areas**
  During construction, the mortality of benthic organisms will be the most catastrophic change in this system. The Spoil Island area is known to have seagrass habitats, sensitive for economically important species of sciaenids and paralichthys. This area is also adjacent to sensitive fish nursery habitat and other areas that are important for a variety of marine life, including possible feeding areas for sea turtles and nesting sites for colonial waterbirds. Thus, these physical and geographical concerns lead to a non-recommendation of these areas as candidate sites.

- **Visual impacts and disturbance of coastal uses**
  Since it is submerged, either of the intake options (infiltration gallery or directional drilled intake) present no concern regarding any type of visual or navigational disturbances upon completion. However, during construction of the infiltration gallery the shipping channel will be affected, since pipes need to be laid down in order to bring the water from the intake to the plant. A directional drill intake might be a better option since drilling can occur without impact to the shipping channel.

- **Impacts on coastal wetlands**
  While the area isn't considered coastal wetlands, there are concerns about negatively impacting the seagrass and Spoil Island habitat if an intake were to be placed in this area.

- **Other environmental issues**
  Spoil Islands have the potential to be a feeding and resting place for migrating birds, including the federally endangered Piping Plover (*Charadrius melodus)*. Altering the island or surrounding shoreline area could decrease the suitability for this area to provide necessary resources for migrating birds.

Site 2B is an onshore surface intake located on the shoreline of the channel extension.

- **Impingement of marine life on screens**
  With the close proximity to seagrasses, it is likely that a traveling screen intake will be a source of mortality for recreationally important species such as sciaenids (e.g. red drum, spotted seatrout) and paralichthys (flounders).

- **Entrainment of marine life in plant**
  In this location, larval fish, eggs, and plankton will be entrained in a traveling screen intake. This area has the potential to significantly impact the recruitment of recreationally important species (e.g. sciaenids and paralichthys) due to the relatively high habitat quality of the surrounding area.

- **Impacts on seagrass and other sensitive marine areas**
  This location is in close proximity to seagrass. Since many species use seagrass beds as recruitment areas, this site is not recommended for development. Like site 2A, this area is also adjacent to some of the most sensitive fish nursery habitat and other areas that are important for a variety of marine life. Thus, these physical and geographical concerns lead to a non-recommendation of these areas as candidate sites.

- **Visual impacts and disturbance of coastal uses**
  As with all surface intakes, this unit (or building housing the unit) will be visible. A portion of the canal might need to be narrowed or closed, which could create problems for ships attempting to unload/load cargo in the surrounding area.

- **Impacts on coastal wetlands**
  The shoreline in this area isn't as heavily developed as Sites 1A and 1B, so creating a surface intake would impact the coastal wetlands.

- **Other environmental issues**
  No other environmental issues have currently been identified.

Site 3: Mustang or Padre Islands

Site 3A is proposed to be located 2 miles offshore, with proposed intake types including submerged wedgewire, submerged infiltration gallery, and submerged directional drilled.

- **Impingement of marine life on screens**
  Constructing a submerged wedgewire intake would have a greater potential for impinging marine fauna as compared to a subsurface intake. Since this location is outside of the Corpus Christi Bay, there is a greater variety of species that may become impinged in the intake. Although there will be mortality associated with the initial creation of a subsurface intake (either filtration gallery or directional drilled) there is no concern about impingement since it does not protrude from the seafloor. It is our biological opinion that this area would have the least impact based on our criteria; however, it is also the least studied. If chosen, further detailed assessment would need to be performed at this area.

- **Entrainment of marine life in plant**
  The wedgewire intake would have significantly higher marine life mortality on a daily operating basis, compared to a subsurface intake where water that is absorbed into the sediment is used. Since the water from a subsurface intake is drawn through the sand/gravel, larvae and eggs in the water column will not filter through the seafloor and are not at risk for entrainment.

- **Impacts on seagrass and other sensitive marine areas**
  During construction, the mortality of benthic organisms will be the most catastrophic change in this system. This location does not appear to have any type of limiting habitat (i.e., seagrasses) that would negatively impact the resident benthic fauna, so it is possible that the motile species will be able to avoid the area during construction and potentially re-settle once construction is complete.

- **Visual impacts and disturbance of coastal uses**
  Since it is submerged offshore, either of the intake options (wedgewire or submerged) present no concern regarding any type of visual or navigational disturbances upon completion.

- **Impacts on coastal wetlands**
  Since this site is outside of Corpus Christi Bay, there are no concerns about negative impacts on coastal wetland.

- **Other environmental issues**
  No other environmental issues have currently been identified.

Site 4: On Stevens WTP

This site is proposed to be located in the Viola Turning basin as an onshore traveling screen surface intake.

- **Impingement of marine life on screens**
  This location is at the end of the Viola Turning basin, which is not a favorable habitat for most species of recreational importance. Impingement will be a concern, but it is likely to be of mostly lower trophic level species (e.g. anchovies, silversides) which can be found throughout the Corpus Christi Bay system. The potential for macroalgae to become impinged is a more serious concern.

- **Entrainment of marine life in plant**
  The abundance of eggs, larval fish, or plankton that get entrained in the surface intake likely will not be as high as the other sites, since the location is so far from any source of inflow. This water may already be slightly more saline than other locations due to evaporation and extended flushing cycles, making it a harsher environment than the other listed sites.

- **Impacts on seagrass and other sensitive marine areas**
  This location does not appear to have any seagrass in the surrounding area.

- **Visual impacts and disturbance of coastal uses**
  As with all surface intakes, this unit (or building housing the unit) will be visible after construction. This channel was created as a shipping lane, so most of the area is already industrialized.

- **Impacts on coastal wetlands**
  Depending on location, the coastal wetlands might be impacted during the creation of the surface intake.

- **Other environmental issues**
  No other environmental issues have currently been identified.

Discharge Facilities Assessment

When considering the locations for desalination plant discharge facilities, several factors need to be considered. The addition of brine concentrate can have environmental impacts on the marine community. As a result, the salinity tolerance of marine organisms should be considered when determining the locations for Corpus Christi desalination plant discharge locations (Figure 2). Changes in salinity and temperature can have deleterious effects on many marine species, particularly those in early developmental stages. See Table 3 for a list of the marine species of bottom dwellers in Corpus Christi Bay.

Biomass, abundance, and diversity of the benthic community can be affected by salinity changes (Montagna et al. 2002, Van Diggelen 2014). The average salinity of the Corpus Christi Bay system is about 35 ± 7 ppt. The estuarine macrobenthic community of Corpus Christi Bay will likely not be affected by a salinity increase within this range (Table 4, Montagna et al. 2013). However, brine plumes can create hypoxic or anoxic zones which disturb benthic communities and organisms in the water column. It is known that there is an interaction between salinity and dissolved oxygen (DO) concentration in Corpus Christi Bay, such that benthic communities decline dramatically as salinity increases to around 42 ppt and DO decreases to around 3 mg/L (Ritter and Montagna 1999). This effect could be heightened due to depressions in Corpus Christi Bay, which constrain mixing of bottom water, leading to hypoxia (Nelson 2012). Directed sampling before and after the construction of a discharge facility is recommended in order to determine the actual environmental impacts to the selected sites.

Some of the proposed discharge sites are recorded as having evidence of contaminant-induced degradation of sediment quality from storm-water outfalls. Sampling should be conducted post-construction to monitor if there is any change in contaminant-induced degradation of sediment quality (Carr et al. 2000).

In the assessment the following key environmental intake issues will be discussed:

- Salinity tolerance of identified marine organisms in the mixing zone
- Marine organism salinity tolerances
- Target acceptable discharge salinity
- Mixing of brine concentrate and ambient seawater issues

- Ion imbalance of brine concentrate and ambient seawater mixing issues
- Toxicity of brine concentrate and ambient seawater mixing issues
- Estimate maximum velocity at edge of mixing zone safe for aquatic life
- Concentrate disposal impacts, diffusion, and transport

Overall recommendations: To limit the environmental impacts on resident fauna, it is our opinion that the best discharge type would be either submerged jet diffusers or a submerged pipe. Submerged jet diffusers would be the quickest method for dilution of effluent and the best way to avoid hypoxia. We recommend site 3A with submerged jet diffusers as the best location for a discharge facility. This combination would have the least environmental impact because the discharge would be entering into a deeper and more dynamic body of water. This site and discharge type combination also appears to have the lowest overall effect on mortality (construction and daily). Overall we recommend the following sites and discharge type combinations (in order of preference):

1. Site 3A as submerged jet diffusers
2. Site 3A as a submerged pipe
3. Site 1B as submerged jet diffusers
4. Site 1B as a submerged pipe
5. Site 4A as a surface open discharge pipe
6. Site 1A as a surface open discharge pipe – drainage ditch
7. Site 2A as submerged jet diffusers
8. Site 2A as a submerged pipe

The following is a site by site assessment of the key environmental issues from construction of discharge facilities. Discharge selection matrix (Table 5) contains site-specific details and other criteria regarding to how these recommendations were determined.

Site 1: Near Broadway WWTP

Discharge location 1A is located in the Inner Harbor of Corpus Christi Bay. Corpus Christi Inner Harbor has been subject to refinery process water effluent discharge for over fifteen years. The proposed type of discharge infrastructure is a surface open discharge pipe – drainage ditch. Brine concentrate in an open-air ditch could evaporate further and become even more saline. Considering salinity alone, a discharge salinity of 2.0 parts per thousand (ppt) above ambient salinity will not have an effect on the marine community in the Inner Harbor. However, the conclusion from Hodges' 2015 report is that desalination brine in the ship channel will likely result in extended periods of hypoxia and anoxia. This location does not appear to have seagrass or other limiting habitat.

- **Salinity tolerance of identified marine organisms in the mixing zone**

The salinity tolerance of marine organisms in the mixing zone is between approximately 28 and 42 ppt, with an average around 35.

- **Marine organism salinity tolerances**
  The Corpus Christi Bay system has natural salinities ranging from 28 - 42 ppt, with an average around 35 ppt. We know that the resident marine species can tolerate salinities within this range; however, further studies are needed to determine the effects of a localized salinity increase greater than 42 ppt.

- **Target acceptable discharge salinity**
  The target acceptable discharge salinity should be 35- 42 ppt, just above the average salinity of the bay system.

- **Mixing of brine concentrate and ambient seawater issues**
  It is unknown how the mixing of warm brine concentrate will affect the bay system, but it could lead to hypoxia. It is recommended that the concentrate is brought as close as possible to ambient seawater temperature before being released.

- **Ion imbalance of brine concentrate and ambient seawater mixing issues**
  The concentration of copper, calcium, chlorine, and anti-scalants in the brine concentrate needs to be determined before its impact can be assessed. Fish, plankton, and benthic fauna can experience toxic effects from the bioaccumulation of metals. Research is needed to verify the potential impacts of brine concentrate mixing with seawater.

- **Toxicity of brine concentrate and ambient seawater mixing issues**
  Warm temperatures of brine plumes may affect marine species, particularly animals in early developmental stages. This site does not appear to have seagrass habitat, so there is little concern for brine concentrate affecting sensitive nursery grounds.

- **Estimate maximum velocity at edge of mixing zone safe for aquatic life**
  At the seafloor there are sluggish currents ranging from 0.01 - 0.25 m/s. The current velocity in Corpus Christi Bay is variable and wind driven at the surface. Current speed is probably very sluggish at this particular site. Brine discharged at a high velocity would promote more mixing but could negatively impact flora and fauna. We estimate the maximum velocity at the edge of mixing zone safe to aquatic life to be no more than 0.5 m/sec.

- **Concentrate disposal impacts, diffusion and transport**
  The acceptable discharge salinity should be close to 35 ppt, and no higher than 42 ppt. Field and laboratory studies should be conducted to investigate the environmental

impacts of warm brine plumes with high concentration of heavy metals. A brine plume at this site would probably lead to hypoxia.

Discharge location 1B is located in Corpus Christi Bay in the Ship Channel near Harbor Bridge. The proposed types of discharge infrastructure are submerged pipe and submerged jet diffusers. This site has previously been described as a depositional zone for material coming from the Inner Harbor (Carr et al. 1998). A submerged pipe would release a brine plume at the sediment surface of the bay. This pipe would be subject to fouling by sessile marine organisms such as serpulid worms and tunicates. Discharge location 1B may experience more wind-driven mixing than location 1A, potentially mixing up the brine plume released from a submerged pipe. However, hypoxia could still develop from the brine plume. Submerged jet diffusers are an alternative discharge type that prevents the formation of dense brine plumes. Turbidity from jet diffusers can cause developmental and filtration problems in bivalves.

- **Salinity tolerance of identified marine organisms in the mixing zone**
  The salinity tolerance of marine organisms in the mixing zone is between approximately 28 and 42 ppt, with an average around 35.

- **Marine organism salinity tolerances**
  The Corpus Christi Bay system has natural salinities ranging from 28 - 42 ppt, with an average around 35 ppt. We know that the resident marine species can tolerate salinities within this range; however, further studies are needed to determine the effects of a localized salinity increase greater than 42 ppt.

- **Target acceptable discharge salinity**
  The target acceptable discharge salinity should be 35- 42 ppt. It would be easier to reach the target acceptable discharge salinity using submerged jet diffusers.

- **Mixing of brine concentrate and ambient seawater issues**
  It is unknown how the mixing of warm brine concentrate will affect the bay system. It is recommended that the concentrate is brought as close as possible to ambient seawater temperature before being released. A submerged pipe would create a brine plume at the sediment surface, which could lead to hypoxia if not thoroughly mixed in. Submerged jet diffusers would be the preferred option to achieve optimal mixing of brine concentrate and seawater.

- **Ion imbalance of brine concentrate and ambient seawater mixing issues**
  The concentration of copper, calcium, chlorine, and anti-scalants in the brine concentrate needs to be determined before its impact can be assessed. Fish, plankton, and benthic fauna can experience toxic effects from the bioaccumulation of metals. Sessile organisms

would be subject to stress from ion imbalance as they cannot relocate. Submerged jet diffusers would be the preferred option to promote mixing and dilution of brine concentrate and seawater.

- **Toxicity of brine concentrate and ambient seawater mixing issues**
  Warm temperatures of brine plumes may affect marine species, particularly animals in early developmental stages. This site does not appear to have seagrass habitat, so there is little concern for brine concentrate affecting sensitive nursery grounds at this site. Research is needed to verify the toxicological effects of brine concentrate mixing with seawater.

- **Estimate maximum velocity at edge of mixing zone safe for aquatic life**
  We estimate the maximum velocity at the edge of mixing zone safe to aquatic life to be no more than 0.5 m/sec. Although marine life would only be exposed to diffuser jet turbulence for short bursts of time, on the order of seconds, we recommend conducting laboratory studies to determine a velocity that minimizes shear stress mortality (Foster et al. 2013).

- **Concentrate disposal impacts, diffusion, and transport**
  The acceptable discharge salinity should be close to 35 ppt, and no higher than 42 ppt. Field and laboratory studies should be conducted to investigate the environmental impacts of warm brine plumes with high concentration of heavy metals. A brine plume at this site could lead to hypoxia. Submerged jet diffusers would be the preferred option to achieve optimal mixing of brine concentrate and seawater.

Site 2: La Quinta Channel Extension

Discharge location 2A is located southwest of La Quinta Channel Extension in Corpus Christi Bay. The proposed types of discharge infrastructure are submerged pipe and submerged jet diffusers. Nearby tidal flats, salt marshes, and seagrass beds are inhabited by protected bird species and used as recruitment areas by recreationally important fish species. Green sea turtles, bottlenose dolphins, and manatees have been observed in La Quinta Channel. Hypoxia or anoxia would occur as a result of submerged pipe brine plume discharge. This site would have the most severe environmental impacts and is not recommended for the construction of a discharge facility.

- **Salinity tolerance of identified marine organisms in the mixing zone**
  The salinity tolerance of marine organisms in the mixing zone is between approximately 28 and 42 ppt, with an average around 35.

- **Marine organism salinity tolerances**
  The Corpus Christi Bay system has natural salinities ranging from 28 - 42 ppt, with an average around 35 ppt. We know that the resident marine species can tolerate salinities within this range; however, further studies are needed to determine the effects of a localized salinity increase greater than 42 ppt.

- **Target acceptable discharge salinity**
  The target acceptable discharge salinity should be 35 - 42 ppt. It would be easier to reach the target acceptable discharge salinity using submerged jet diffusers.

- **Mixing of brine concentrate and ambient seawater issues**
  Submerged jet diffusers dilute and disperse brine through rapid mixing, decreasing the possibility or extent of hypoxic zones.

- **Ion imbalance of brine concentrate and ambient seawater mixing issues**
  The concentration of copper, calcium, chlorine, and anti-scalants in the brine concentrate needs to be determined before its impact can be assessed. Fish, plankton, and benthic fauna can experience toxic effects from the bioaccumulation of metals. Sessile organisms would be subject to stress from ion imbalance as they cannot relocate. Submerged jet diffusers would be the preferred option to promote mixing and dilution of brine concentrate and seawater.

- **Toxicity of brine concentrate and ambient seawater mixing issues**
  Warm temperatures of brine plumes may affect marine species, particularly those in early developmental stages. This site has seagrass habitat that is potentially a recruitment area for many estuarine species. Discharge from a submerged pipe could be particularly detrimental by causing hypoxia. Submerged jet diffusers could create turbidity, affecting the phytoplankton community and shading out seagrass. A discharge facility at this site could have severe environmental impacts. More research is needed to verify the toxicological effects of brine concentrate mixing with seawater.

- **Estimate maximum velocity at edge of mixing zone safe for aquatic life**
  If the submerged jet diffuser was installed at the bottom of the 35' trench, as proposed, a velocity of 2 - 3 fps at the edge of the mixing zone would be acceptable. However, if the submerged jet diffuser was installed at the average seafloor depth of ~3 m, there could be severe environmental impacts, as mentioned above. We estimate the maximum velocity at the edge of mixing zone safe to aquatic life to be no more than 0.5 m/sec. Although marine life would only be exposed to diffuser jet turbulence for short bursts of time, on

the order of seconds, we recommend conducting laboratory studies to determine a velocity that minimizes shear stress mortality (Foster et al. 2013).

- **Concentrate disposal impacts, diffusion, and transport**
  The target discharge salinity should be close to 35 ppt, and no higher than 42 ppt. Field and laboratory studies should be conducted to investigate the environmental impacts of warm brine plumes with high concentration of heavy metals. A brine plume at this site would probably lead to hypoxia. A submerged pipe is also subject to fouling by sessile marine organisms such as serpulid worms and tunicates. Submerged jet diffusers would be the preferred option to achieve optimal mixing of brine concentrate and seawater.

Site 3: Mustang Island or Padre Island
Discharge location 3A is located 2 miles offshore of either Mustang Island or Padre Island. The proposed types of discharge infrastructure are submerged pipe or submerged jet diffusers. This is the best choice for a discharge site because the brine effluent would be rapidly mixed into the ambient seawater and have the least environmental impact. Kemp's ridley, loggerhead, green and leatherback turtles as well as bottlenose dolphins have been recorded at this site. It is unlikely that these species will be affected by the discharge.

- **Salinity tolerance of identified marine organisms in the mixing zone**
  The salinity tolerance of marine organisms in the mixing zone is between approximately 32 and 36 ppt, with an average of 35 ppt.

- **Marine organism salinity tolerances**
  The Gulf of Mexico has natural salinities ranging from 32 - 36 ppt, with an average around 35 ppt. We know that the resident marine species can tolerate salinities within this range; however, further studies are needed to determine the effects of a localized salinity increase greater than 36 ppt.

- **Target acceptable discharge salinity**
  The target acceptable discharge salinity should be 35 - 38 ppt. It would be easier to reach the target acceptable discharge salinity using submerged jet diffusers.

- **Mixing of brine concentrate and ambient seawater issues**
  The discharge of brine concentrate from a submerged pipe is expected to mix well with ambient seawater. Submerged jet diffusers would be the best option for quickest dilution and least environmental impact.

- **Toxicity of brine concentrate and ambient seawater mixing issues**
  It is not anticipated that there will be issues with brine concentrate toxicity at this site. Effluent would be thoroughly mixed in through wind-driven mixing and tidal currents.

- **Ion imbalance of brine concentrate and ambient seawater mixing issues**
  The concentration of copper, calcium, chlorine, and anti-scalants in the brine concentrate needs to be determined before its impact can be assessed. Fish, plankton, and benthic fauna can experience toxic effects from the bioaccumulation of metals. Sessile organisms would be subject to stress from ion imbalance as they cannot relocate. Submerged jet diffusers would be the preferred option to promote mixing and dilution of brine concentrate and seawater.

- **Estimate maximum velocity at edge of mixing zone safe for aquatic life**
  The average current velocity near Bob Hall Pier is between 0.5 and 1 m/sec. The current velocity at this discharge site changes every day. We estimate the maximum velocity at the edge of mixing zone safe to aquatic life to be no more than 1.5 m/sec.

- **Concentrate disposal impacts, diffusion and transport**
  The target discharge salinity should be close to 35 ppt, and no higher than 36 ppt. Field and laboratory studies should be conducted to investigate the environmental impacts of warm brine plumes with high concentration of heavy metals. A submerged pipe is also subject to fouling by sessile marine organisms such as serpulid worms and tunicates. Submerged jet diffusers would be the preferred option to achieve optimal mixing of brine concentrate and seawater.

Site 4: ON Stevens WTP

Discharge location 4A is at the Tule Lake Turning Basin in the Inner Harbor of Corpus Christi Bay. The proposed discharge infrastructure is a surface open discharge pipe. Considering salinity alone, a discharge salinity of 2.0 parts per thousand (ppt) above ambient salinity will not have an effect on the marine community in the Inner Harbor. However, the conclusion from Hodges' 2015 report is that desalination brine released in the ship channel will likely result in extended periods of hypoxia and anoxia. This location does not appear to have seagrass or other limiting habitat.

- **Salinity tolerance of identified marine organisms in the mixing zone**
  The salinity tolerance of marine organisms in the mixing zone is between approximately 28 and 42 ppt, with an average around 35.

- **Marine organism salinity tolerances**
  The Corpus Christi Bay system has natural salinities ranging from 28 - 42 ppt, with an average around 35 ppt. We know that the resident marine species can tolerate salinities within this range; however, further studies are needed to determine the effects of a localized salinity increase greater than 42 ppt.

- **Target acceptable discharge salinity**
  The target acceptable discharge salinity should be 35 - 42 ppt.

- **Mixing of brine concentrate and ambient seawater issues**
  A surface open discharge pipe would release brine concentrate directly into the bay. The dense concentrate would settle at the bottom of the harbor and cause hypoxia.

- **Ion imbalance of brine concentrate and ambient seawater mixing issues**
  The concentration of copper, calcium, chlorine, and anti-scalants in the brine concentrate needs to be determined before its impact can be assessed. Fish, plankton, and benthic fauna can experience toxic effects from the bioaccumulation of metals. Sessile organisms would be subject to stress from ion imbalance as they cannot relocate.

- **Toxicity of brine concentrate and ambient seawater mixing issues**
  Warm temperatures of brine plumes may affect marine species, particularly animals in early developmental stages. This site does not appear to have seagrass habitat or recreational fish species, so there is little concern for brine concentrate affecting sensitive nursery grounds.

- **Estimate maximum velocity at edge of mixing zone safe for aquatic life**
  At the seafloor there are sluggish currents ranging from 0.01 - 0.25 m/s. The current velocity in Corpus Christi Bay is variable and wind driven at the surface. Current speed is probably very sluggish at this particular site. Brine discharged at a high velocity would promote more mixing but could negatively impact flora and fauna. We estimate the maximum velocity at the edge of mixing zone safe to aquatic life to be no more than 0.5 m/sec.

- **Concentrate disposal impacts, diffusion, and transport**
  The acceptable discharge salinity should be close to 35 ppt, and no higher than 42 ppt. Field and laboratory studies should be conducted to investigate the environmental impacts of warm brine plumes with high concentration of heavy metals. A brine plume at this site would probably lead to hypoxia.

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Figure 1. Intake Assessment Locations

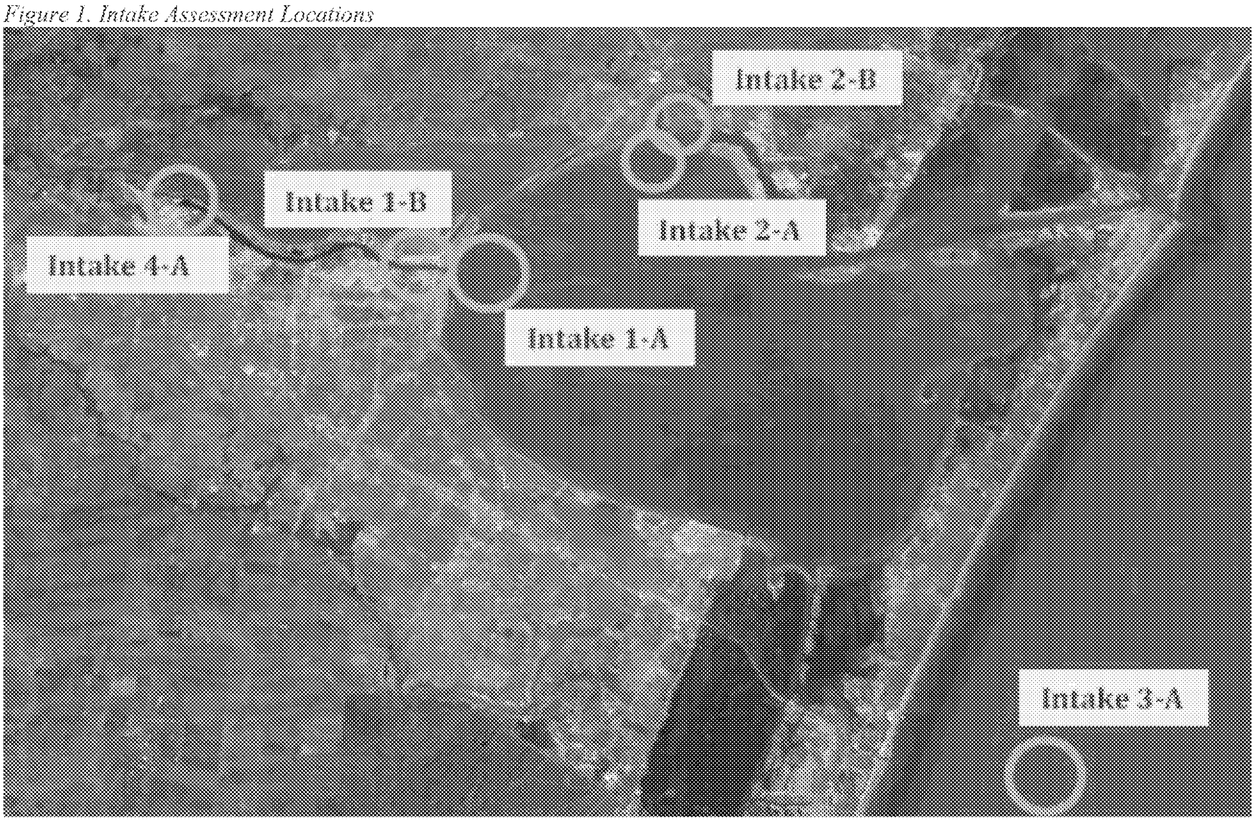


Figure 2. Discharge Assessment Locations

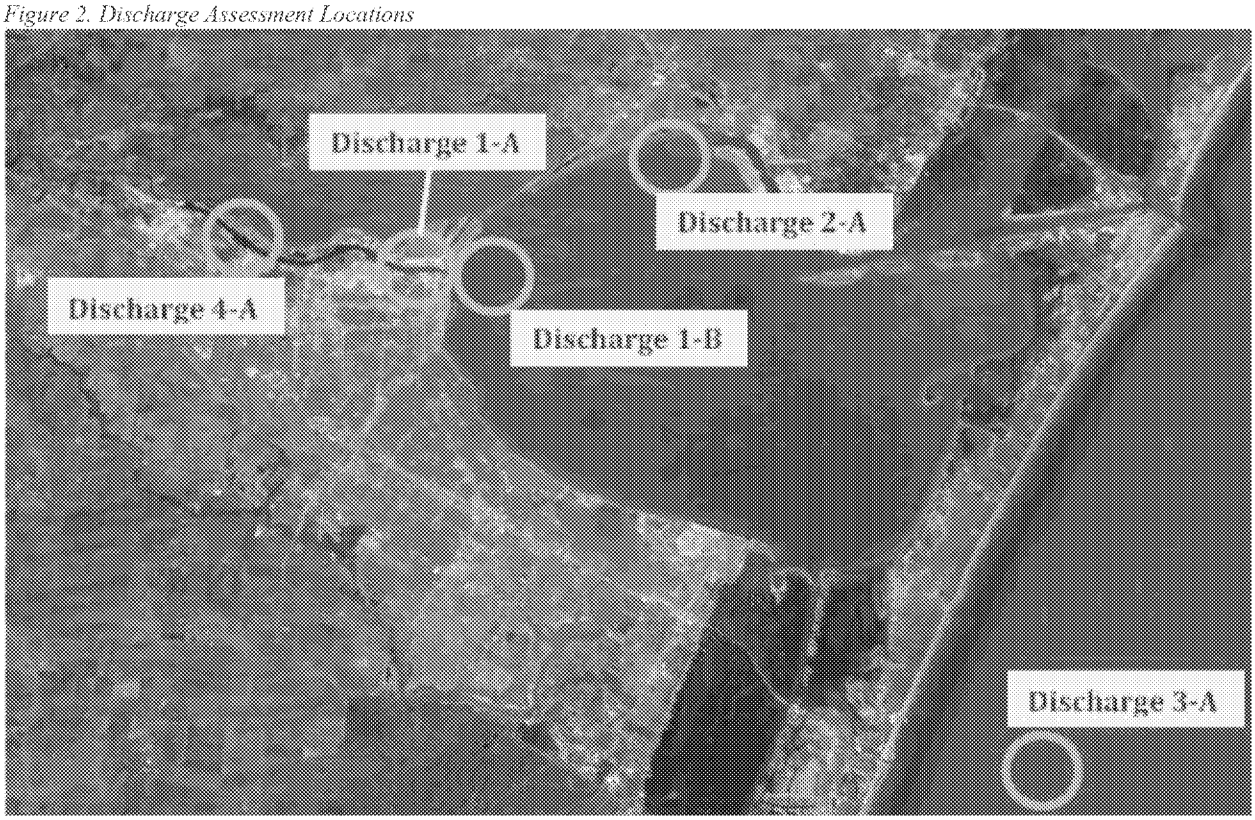


Table 1. Intake type and site location recommendations. A total impact score is given for each intake and the sites are color coded by recommendation level.

Intake Matrix	Site 3A Mustang or Padre Islands	Site 1A CC Bay by CC Harbor	Site 4A Viola Turning Basin	Site 1B CC Turning Basin, Inner Harbor	Site 2A West of Spoil Island	Site 2B Shoreline near La Quinta Channel
Subsurface Intake			N/A	N/A		N/A
Impingement of Marine Life	0	0	N/A	N/A	0	N/A
Entrainment of Marine Life	0	0	N/A	N/A	0	N/A
Impacts on Submerged Aquatic Vegetation	2	2	N/A	N/A	3	N/A
Impacts on Other Sensitive Marine Areas	0	0	N/A	N/A	3	N/A
Visual Impacts	0	0	N/A	N/A	2	N/A
Disturbances of Coastal Uses	1	2	N/A	N/A	2	N/A
Impacts on Coastal Wetlands	0	0	N/A	N/A	3	N/A
Other Environmental Issues	0	0	N/A	N/A	2	N/A
Total Impact Score	**3**	**4**	N/A	N/A	**15**	N/A
Off-shore, Open Intake			N/A	N/A		N/A
Impingement of Marine Life	2	2	N/A	N/A	3	N/A
Entrainment of Marine Life	2	2	N/A	N/A	3	N/A
Impacts on Submerged Aquatic Vegetation	2	2	N/A	N/A	3	N/A
Impacts on Other Sensitive Marine Areas	0	0	N/A	N/A	3	N/A
Visual Impacts	0	0	N/A	N/A	2	N/A
Disturbances of Coastal Uses	1	2	N/A	N/A	2	N/A
Impacts on Coastal Wetlands	0	0	N/A	N/A	3	N/A
Other Environmental Issues	0	0	N/A	N/A	2	N/A
Total Impact Score	**7**	**8**	N/A	N/A	**21**	N/A
On-shore, Open Intake	N/A	N/A			N/A	
Impingement of Marine Life	N/A	N/A	3	3	N/A	3
Entrainment of Marine Life	N/A	N/A	3	3	N/A	3
Impacts on Submerged Aquatic Vegetation	N/A	N/A	1	1	N/A	3
Impacts on Other Sensitive Marine Areas	N/A	N/A	0	0	N/A	3
Visual Impacts	N/A	N/A	2	2	N/A	3
Disturbances of Coastal Uses	N/A	N/A	0	1	N/A	3
Impacts on Coastal Wetlands	N/A	N/A	2	2	N/A	3
Other Environmental Issues	N/A	N/A	0	0	N/A	2
Total Impact Score	N/A	N/A	**11**	**12**	N/A	**23**

Impact Factor:	Recommendation Key (based on the impact factor scores)
0 - No Impact	Preferred
1 - Minimal Impact	Alternative
2 - Moderate Impact	Not Recommended
3 - Severe Impact	Not Applicable

Table 2. Preliminary list of fish and invertebrates that could potentially be impacted by local intake systems. Further study is needed before a site specific list can be created.

Fish		Crustaceans	
Common Name	**Scientific Name**	**Common Name**	**Scientific Name**
American Halfbeak	*Hyporhamphus meeki*	Blue Crab	*Callinectes sapidus*
Atlantic Brief Squid	*Lolliguncula brevis*	Gulf Crab	*Callinectes similis*
Atlantic Bumper	*Chloroscombrus chrysurus*	Brown Shrimp	*Penaeus aztecus*
Atlantic Croaker	*Micropogonias undulatas*	Pink Shrimp	*Penaeus duorarum*
Bay Anchovy	*Anchoa mitchilli*	White Shrimp	*Penaeus setiferus*
Black Drum	*Pogonias cromis*	Cleaner Shrimp	*Hippolytidae*
Blue Fish	*Pomatomus saltatrix*	Grass Shrimp	*Palaemonidae*
Code Goby	*Gobiosoma robustum*	Mysid Shrimp	*Mysidae*
Darter Goby	*Ctenogobius boleosoma*		
Feather Blenny	*Hypsoblennius hentz*		
Green Goby	*Microgobius thalassinus*		
Gulf Flounder	*Paralichthys albigutta*		
Gulf Menhaden	*Brevoortia patronus*		
Hogchoaker	*Trinectes maculatas*		
Inshore Lizardfish	*Synodus foetens*		
Ladyfish	*Elops saurus*		
Lizardfish	*Synodontidae sp.*		
Naked Goby	*Gobiosoma bosc*		
Pinfish	*Lagodon rhomboides*		
Pipefish	*Syngnathidae sp.*		
Puffer Fish	*Tetradontidae sp.*		
Red Drum	*Sciaenops ocellatus*		
Sand Seatrout	*Cynoscion arenarius*		
Sand Seatrout	*Cynoscion arenarius*		
Sea Robin	*Triglidae sp.*		
Shrimp eel	*Ophichthus gomesii*		
Silver Perch	*Bairdiella chrysoura*		
Silversides	*Menidia sp.*		
Skilletfish	*Gobiesox strumosus*		
Southern Flounder	*Paralichthys lethostigma*		
Spot Croaker	*Leiostomus xanthurus*		
Spotfin Mojarra	*Eucinostomus argenteus*		
Spotted Seatrout	*Cynoscion nebulosus*		
Striped Mullet	*Mugil cephalus*		
Stripped Burrfish	*Chilomycterus schoepfi*		
Stripped Mullet	*Mugil cephalus*		
Tarpon	*Megalops atlanticus*		

Table 3. Marine species list of bottom dwellers for Corpus Christi Bay. Adapted from Table 12 of Sediment Quality Assessment of Storm Water Outfalls and other Selected Sites in the Corpus Christi Bay National Estuary Program Study Area. Corpus Christi Bay National Estuary Program - CCBNEP-32, September 1998.

Phyla	Class/Order	Species
Anthozoa		unidentified Anthozoans
Turbellaria		unidentified Turbellaria
Nermertinea		*Phoronis architecta*
Mollusca	Gastropoda	*Acteocina canaliculata*
		Cyclinella tenuis
		Crepidula sp
		Crepidula plana
		unidentified Vitrinellidae
		Caecum pulchellum
		Nassarius acutus
		Nassarius vibex
		Anachis obesa
		Pyrgiscus sp.
Mollusca	Pelecypoda	unidentified Pelecypoda
		Nuculana acuta
		Aligena texasiana
		Mysella planulata
		Mulinia lateralis
		Abra aequalis
		Cumingia tellinoides
		Tagelus divisus
		Anomalocardia auberiana
		Chione cancellata
		Lyonsia hyalina floridana
		Periploma margaritaceum
Annelida	Polychaeta	*Malmgreniella taylori*
		Paleanotus heteroseta
		Paramphinome jeffreysii
		Mystides rarica
		Eteone heteropoda
		Cabira incerta
		Ancistrosyllis groenlandica
		Sigambra sp.
		Gyptis vittata
		Microphthalmus abberrans
		Syllis cornuta
		Exogone sp.
		Brania clavata
		Sphaerosyllis sp. A

Phyla	Class/Order	Species
		unidentified Syllidae
Annelida	Polychaeta	*Ceratonereis irritabilis*
		Laeonereis culveri
		unidentified Nereidae
		Glycinde solitaria
		Lysidice ninetta
		Diopatra cuprea
		Onuphis eremita
		Lumbrineris parvapedata
		Drilonereis magna
		Schistomeringos rudolphi
		Schistomeringos sp. A
		Polydora ligni
		Paraprionospio pinnata
		Apoprionospio pygmaea
		Prionospio heterobranchia
		Scolelepis texana
		Spiophanes bombyx
		Spio pettiboneae
		Polydora socialis
		Streblospio benedicti
		Polydora caulleryi
		Polydora sp.
		Magelona pettiboneae
		Magelona phyllisae
		Magelona rosea
		Spiochaetopterus costarum
		Tharyx setigera
		Cossura delta
		Haploscoloplos foliosus
		Scolopus rubra
		Haploscoloplos sp.
		Naineris sp. A
		Aricidea fragilis
		Cirrophorus lyra
		Aricidea catharinae
		Paraonis fulgens
		Armandia agilis
		Armandia maculata
		Capitella capitata
		Notomastus latericeus
		Notomastus cf. latericeus

Phyla	Class/Order	Species
Annelida	Polychaeta	*Mediomastus ambiseta*
		unidentified Capitellidae
		Branchioasychis americana
		Clymenella torquata
		Asychis elongata
		Euclymene sp. B
		Axiothella mucosa
		Axiothells sp. A
		unidentified Maldanidae
		Isolda pulchella
		Melinna maculata
		unidentified Terebellidae
		Fabricia sp. A
		Chone sp.
		Megalomma bioculatum
		Pomatoceros americanus
		Eupomatus dianthus
		Eupomatus protulicola
Oligochaeta		unidentified Oligochaetes
Sipuncula		*Phascolion strombi*
Crustacea	Branchiopoda	*Latonopsis occidentalis*
Crustacea	Ostracoda	*Sarsiella texana*
		Sarsiella zostericola
Crustacea	Copepoda	*Pseudodiaptomus coronatus*
Crustacea	Branchiura	*Argissa hamatipes*
Crustacea	Malacostraca	*Pagurus annulipes*
		Pagurus longicarpus
		Pinnixa sp.
		Megalops
Crustacea	Cumacea	*Leptocuma* sp.
Crustacea	Amphipoda	unidentified Amphipoda
		Ampelisca sp. B
		Ampelisca abdita
		Synchelidium americanum
		Erichthonias brasiliensis
		Corophium ascherusicum
		Corophium louisianum
		Microprotopus sp.
		Grandidierella bonnieroides
		Batea catharinensis
		Listriella clymenellae
		Caprellidae sp.

Phyla	Class/Order	Species
		Amphilochus sp.
Crustacea	Isopoda	*Xenanthura brevitelson*
		Idotea montosa
Crustacea	Tanaidacea	*Leptochelia rapax*
Echinodermata	Ophiuroidea	unidentified Ophiuroidea
	Holothuroidea	*Thyome mexicana*
Chordata	Urochordata	unidentified Ascidiacea
	Hemichordata	*Schizocardium* sp.

Table 4. Selected references for salinity effects on estuarine macrobenthic and epibenthic organisms.

Authors	Organism(s) Studied	Study Location	Salinity Tolerance Results
Chadwick & Feminella (2001)	Burrowing mayfly *Hexagenia limbata*	USA (Alabama)	Laboratory bioassays showed that *H. limbata* nymphs could survive elevated salinities (LC50 of 6.3 ppt at 18 °C, 2.4 ppt at 28 °C). Similar growth rates at 0,2,4, & 8 ppt.
Saoud & Davis (2003)	Juvenile brown shrimp *Farfantepenaeus aztecus*	USA (Alabama)	Growth significantly higher at salinities of 8 & 12 ppt than at salinities of 2 and 4 ppt.
Tolley et al. (2006)	Oyster reef communities of decapod crustaceans & fish	USA (Florida)	Upper stations (~20 ppt) and stations near high-flow tributaries (6-12 $m^3 s^{-1}$) were typified by decapod *Eurypanopeus depressus* & gobiid fishes. Downstream stations (~30 ppt) and stations near low-flow tributaries (0.2-2 $m^3 s^{-1}$) were typified by decapods *E*
Montagna et al. (2008a)	Southwest Florida mollusc communities	USA (Florida)	*Corbicula fluminea*, *Rangia cuneata*, & *Neritina usnea* only species to occur < 1 psu. *R. cuneata* good indicator of mesohaline salinity zones with tolerence to 20 psu. Gastropod *N. usnea* common in fresh to brackish salinities. *Polymesoda caroliniana* prese
Montague & Ley (1993)	Submersed vegetation & benthic animals	USA (Florida)	Mean salinity ranged from ~11-31 ppt. Standard deviation of salinity was best environmental correlate of mean plant biomass and benthic animal diversity. Less biota at stations with greater fluctuations in salinity. For every 3 ppt increase in standard

Authors	Organism(s) Studied	Study Location	Salinity Tolerance Results
Rozas et al. (2005)	Estuarine macrobenthic community	USA (Louisiana)	Increased density and biomass with increases in freshwater inflow and reduced salinities. Salinity ranged from 1-13 psu.
Finney (1979)	Harpacticoid copepods *Tigriopus japonicus*, *Tachidius brevicornis*, *Tisbe sp.*	USA (Maryland)	All species tested for response to salinities from 0-210 ppt. *Tigriopus* became dormant at 90 ppt died at 150 ppt. *Tachidius* became dormant at 60 ppt, died at 150 ppt. *Tisbe* died shortly after exposure to 45 ppt.
Kalke & Montagna (1991)	Estuarine macrobenthic community	USA (Texas)	Chironomid larvae & polychaete *Hobsonia florida*: increased densities after freshwater inflow event (1-5 ppt). Mollusks *Mulinia lateralis & Macoma mitchelli:* increased densities & abundance during low flow event (~20 ppt). *Streblospio benedicti* & *Medioma*
Keiser & Aldrich (1973)	Postlarval brown shrimp *Penaeus aztecus*	USA (Texas)	Shrimp selected for salinities between 5-20 ppt.
Montagna et al. (2002b)	Estuarine macrobenthic community	USA (Texas)	Macrofauna increased abundances, biomass & diversity with increased inflow; decreased during hypersaline conditions. Macrofaunal biomass & diversity had nonlinear bell-shaped relationship with salinity: maximum biomass at ~19 ppt
Zein-Eldin (1963)	Postlarval brown shrimp *Penaeus*	USA (Texas)	In laboratory experiments with temperatures 24.5-26.0 □C, postlarvae grew equally well in salinities of 2-40 ppt.

Authors	Organism(s) Studied	Study Location	Salinity Tolerance Results
	aztecus		
Zein-Eldin & Aldrich (1965)	Postlarval brown shrimp *Penaeus aztecus*	USA (Texas)	In laboratory experiments with temperatures < 15 □C, postlarval survivial decreased in salinities < 5 ppt.
Allan et al. (2006)	Caridean shrimp *Palaemon peringueyi*	South Africa	At constant salinity of 35 ppt, respiration rate increased with increased temperature. At constant temperature of 15 □C, respiration rate increased with increased salinity.
Ferraris et al. (1994)	Snapping shrimp *Alpheus viridari*, Polychaete *Terebellides parva*, sipunculan *Golfingia cylindrata*	Belize	Organisms subjected to acute, repeated exposure to 25, 35, or 45 ppt. *A. viridari* hyperosmotic conformer at decreased salinity, but osmoconformer at increased saliniry. *G. cylindrata* always osmoconformer. *T. parva* always osmoconformer; decreased survival.
Lercari et al. (2002)	Sandy beach macrobenthic community	Uruguay	Abundance, biomass, species richness, diversity & evenness significantly increased from salinity of ~6 ppt to salinity of ~25 ppt.
Chollett & Bone (2007)	Estuarine macrobenthic community	Venezuela	Immediately after heavy rainfall (~25 psu), spionid polychaetes showed large increases in density & richness versus normal values (~41 psu).
Dahms (1990)	Harpacticoid copepod	Germany (Helgoland)	After 2 hours, no mortality in salinities of 25-55 ppt. Almost all displayed dormant

Authors	Organism(s) Studied	Study Location	Salinity Tolerance Results
	Paramphiascella fulvofasciata		behavior < 20 ppt and > 55 ppt.
McLeod & Wing (2008)	Bivalves *Austrovenus stutchburyi* & *Paphies australis*	New Zealand	Sustained exposure (> 30 d) to salinity < 10 ppt significantly decreased survivorship.
Rutger & Wing (2006)	Esturaine macroinfaunal community	New Zealand	Infaunal community in low salinity regions (2-4 ppt) showed low species richness & abundance of bivalves, decapods, & Orbiniid polychaetes, but high abundance of amphipods & Nereid polychaetes compared to higher salinity regions (12-32 ppt).
Drake et al. (2002)	Estuarine macrobenthic community	Spain	Species richness, abundance, and biomass decreased in the upstream direction, positively correlated with salinity. Highly significant spatial variation in macrofaunal communities along the salinity gradient. Salinity range: 0-40 ppt.
Normant & Lamprecht (2006)	Benthic amphipod *Gammarus oceanicus*	Baltic Sea	Low salinity basin (5-7 psu). Physiological performance examined from 5-30 psu. Feeding & metabolic rates decreased with increasing salinity; nutritive absorption increased. Faeces production & ammonia excretion rates decreased strongly from lowest to

Table 5. Discharge matrix

Discharge Matrix	Site 3A Mustang or Padre Islands	Site 1B CC Turning Basin, Inner Harbor	Site 4A Tule Lake Turning Basin	Site 1A CC Bay by CC Harbor	Site 2A SW of La Quinta Channel
Surface Open Discharge Drainage Ditch					
Marine Species in Estimated Mixing Zone	N/A	N/A	N/A		N/A
Organisms in Water Column	N/A	N/A	N/A	1	N/A
Bottom Dwellers	N/A	N/A	N/A	1	N/A
Endangered Species	N/A	N/A	N/A	0	N/A
Salinity Tolerance of Identified Organisms in Mixing Zone	N/A	N/A	N/A	2	N/A
Target Acceptable Discharge Salinity	N/A	N/A	N/A	3	N/A
Mixing of Brine Concentrate and Ambient Seawater Mixing Issues	N/A	N/A	N/A	2	N/A
Ion Imbalance of Brine Concentrate and Ambient Seawater Mixing Issues	N/A	N/A	N/A	2	N/A
Toxicity of Brine Concentrate and Ambient Seawater Mixing Issues	N/A	N/A	N/A	3	N/A
Estimate Maximum Velocity at Edge of Mixing Zone, Safe to Aquatic Life	N/A	N/A	N/A	1	N/A
Other Environmental Issues	N/A	N/A	N/A	2	N/A
Total Impact Score	N/A	N/A	N/A	17	N/A
Off-shore, Submerged Discharge					
Marine Species in Estimated Mixing Zone			N/A	N/A	
Organisms in Water Column	0	1	N/A	N/A	3
Bottom Dwellers	1	1	N/A	N/A	3
Endangered Species	0	0	N/A	N/A	1
Salinity Tolerance of Identified Organisms in Mixing Zone	1	1	N/A	N/A	3
Target Acceptable Discharge Salinity	1	1	N/A	N/A	3
Mixing of Brine Concentrate and Ambient Seawater Mixing Issues	0	2	N/A	N/A	3
Ion Imbalance of Brine Concentrate and Ambient Seawater Mixing Issues	0	1	N/A	N/A	3
Toxicity of Brine Concentrate and Ambient Seawater Mixing Issues	1	2	N/A	N/A	3
Estimate Maximum Velocity at Edge of Mixing Zone, Safe to Aquatic Life	0	1	N/A	N/A	2
Other Environmental Issues	1	1	N/A	N/A	3
Total Impact Score	5	11	N/A	N/A	27
Surface Open Discharge Pipe					
Marine Species in Estimated Mixing Zone	N/A	N/A		N/A	N/A
Organisms in Water Column	N/A	N/A	1	N/A	N/A
Bottom Dwellers	N/A	N/A	1	N/A	N/A
Endangered Species	N/A	N/A	0	N/A	N/A
Salinity Tolerance of Identified Organisms in Mixing Zone	N/A	N/A	2	N/A	N/A
Target Acceptable Discharge Salinity	N/A	N/A	2	N/A	N/A
Mixing of Brine Concentrate and Ambient Seawater Mixing Issues	N/A	N/A	3	N/A	N/A
Ion Imbalance of Brine Concentrate and Ambient Seawater Mixing Issues	N/A	N/A	2	N/A	N/A
Toxicity of Brine Concentrate and Ambient Seawater Mixing Issues	N/A	N/A	3	N/A	N/A
Estimate Maximum Velocity at Edge of Mixing Zone, Safe to Aquatic Life	N/A	N/A	2	N/A	N/A
Other Environmental Issues	N/A	N/A	1	N/A	N/A
Total Impact Score	N/A	N/A	17	N/A	N/A

Impact Factor:	Recommendation Key (based on the impact factor scores)
0 - No Impact	Preferred
1 - Minimal Impact	Alternative
2 - Moderate Impact	Not Recommended
3 - Severe Impact	Not Applicable

ATTACHMENT C

TEXAS PARKS & WILDLIFE

Life's better outside.®

June 12, 2018

Office of the Chief Clerk, MC-105
Texas Commission on Environmental Quality
PO Box 13087
Austin, TX 78711-3087

Re: TCEQ Industrial Wastewater Discharge NORI for Permit Number WQ0005254000

Dear Sir or Madam:

The Texas Parks and Wildlife Department (TPWD) appreciates the opportunity to provide comment on the application for the proposed Texas Pollutant Discharge Elimination System (TPDES) industrial wastewater discharge permit for Port of Corpus Christi Authority of Nueces County. (Permit No. WQ0005254000). TPWD is the agency with primary responsibility for protecting the state's fish and wildlife resources (Texas Parks and Wildlife Code §12.0011(a)) in addition to encouraging outdoor recreation on Texas water resources. With respect to this role, we are concerned about water quality for fish and wildlife. Additionally, we are charged with providing information on fish and wildlife resources to any local, state, and federal agencies or private organizations that make decisions affecting those resources (Texas Parks and Wildlife Code §12.0011(b)(3)). Please be aware that a written response to a TPWD recommendation for informational comment received by a state government agency may be required by state law. For further guidance, please see Texas Parks & Wildlife Code Section 12.0011.

In light of the statutory mandate, TPWD staff have reviewed the aforementioned TPDES permit application and offer our comments.

Based on the information provided in the permit application, there seems to be a discrepancy in the location of the outfall between the cited latitude/longitude in the first part of the application on page 9 (27.524566, -97.164738) and the one listed on page 6 of the Technical Report 1.0 found later in the application (27.87935, -97.27983). TPWD assume the location referenced in the Technical Report is the correct location. Attachment A to this letter contains a map (Figure 1) of the two locations listed in the permit application and Technical Report 1.0 and

4200 SMITH SCHOOL ROAD
AUSTIN, TEXAS 78744-3291
512.389.4800
www.tpwd.texas.gov

TPWD would appreciate clarification from the applicant on this discrepancy.

Based on TPWD's review of the permit application, the proposed temperature range of the effluent may pose a concern to the La Quinta Channel fishery. As stated in the permit application Technical Report 1.0, page 9, a range of 14-32 °C is planned.

One point of clarification needed as well is the Technical Report table actually says °F, so we assume that is a mistake that should be corrected to °C.

TPWD is concerned that increased temperatures, especially in the winter months, could pose a problem for the spawning habitat, specifically for black drum, in La Quinta Channel by the release of warm water from Outfall 001. There is a popular black drum fishery in La Quinta Channel during the winter for "bull drum" (large sexually mature fish). This is mostly a catch and release fishery (these fish are usually oversized and cannot be legally harvested). Depending on the spatial extent of any potential water temperature increase in La Quinta Channel, this fishery, used by fishing guides and recreational anglers, might be impacted.

TPWD would like to see additional information regarding the results of the modeling analysis for water temperature from Outfall 001 in the area of the outfall.

With regards to the use of the CORMIX model in this application, TPWD has a series of questions and we would appreciate any clarification the permittee or TCEQ can provide. These questions are found in Attachment B to this letter.

Related to salinity concerns with the model, TPWD also has questions about the effects of this discharge on dissolved oxygen in the area of the discharge and beyond. TPWD would like clarification on how dissolved oxygen levels are modeled, especially as it relates to dissolved oxygen solubility in the presence of higher temperatures and higher salinities and whether this proposed location and volume of discharge could create a hypoxic zone.

TPWD recommends that the permittee and TCEQ consult with TPWD coastal fisheries staff knowledgeable of the potential impacts from this discharge related to temperature changes, salinity, and dissolved oxygen within this section of the La Quinta Channel prior to finalizing the permit.

TPWD requests that these comments be considered during the technical review of the proposed permit application. We appreciate the opportunity to offer comment and look forward to working with TCEQ, the applicant, and other stakeholders on this matter. If you have questions or need more information, please contact me at anne.rogers@tpwd.texas.gov or (512) 389-8687. Thank you again for the opportunity to comment and for the opportunity to work collaboratively with you and your colleagues to conserve and protect Texas' valued aquatic resources.

Sincerely,

Anne R. Harrison

Anne Rogers Harrison
Water Quality Program Leader

ARH:ms

Attachment

cc: Ms. Cindy Loeffler
Mr. James Murphy
Mr. Alex Nunez
Mr. Brian Bartram

Attachment A.

Figure 1. Location of Port of Corpus Christi Authority's desalination plant outfall per latitude/longitude in permit application and Technical Report 1.0.

Attachment B

The following is a series of questions on the use of the CORMIX model as it was used in the permit application, followed by documentation from the CORMIX website (italics), as well as quotations from the permit application. TPWD would appreciate clarification on these questions.

- What tidal information was used to drive the tidal mixing component of CORMIX? This is especially important to the buoyancy of the discharge in relation to boundary interactions to accurately predict mixing behavior.

  CORMIX needs some information on the ambient design conditions relative to any of the two slack tides.
  The rate reversal (time gradient of the tidal velocity) near these slack tides is of considerable importance for the concentration build-up in the transient discharge plume.

  Tidal reversals will reduce the effective dilution of a discharge by re-entraining the discharge plume remaining from the previous tidal cycle.

  CORMIX considers the reduction in initial dilution due re-entrainment of material remaining from the previous cycle. It does not consider unsteady build-up of material over several tidal cycles, it assumes a complete flushing of the historic plume in the near-field, will occur within a tidal cycle.

- Because salinity is considered a conservative constituent (not affected by biological processes), what data was used to formulate to ambient conditions in the near-field and far-field dilution zones? This applies to the depth integrated area of the channel, with respect to the multiport diffusers.

  Conservative Pollutant - The pollutant specified does not undergo any decay/growth process during mixing.

- From Page 10, Amec, Foster& Wheeler, <u>Brine Discharge Mixing Analysis, Dec 2017</u>

  > "In considering the effect of stratification in these analyses, the salinity and temperature values at the top and bottom of the water column were paired. Given the available ambient data set from the TCEQ, the top depth

represents salinity at a depth of 0.3 meters. The bottom depths represent salinity at a depth of 3 meters. The average density differences between the top and bottom of the water column at these depths were calculated to be 0.06 kg/m3. Because the difference in density is less than 0.1 kg/m3, stratification does not need to be considered in the analysis in accordance with CORMIX guidance".

With the proposed depth of the diffusers set at 44 ft (13.4 meters), are these assumptions of 'no stratification' in the channel still valid?

- The effluent from the plant is estimated to be 1.63-1.88 X higher in salinity of the ambient receiving waters (66,000 – 77,460 mg/L TDS), and as such, will be negatively buoyant and likely sink (even with the multiport diffusers). Has the bottom topography of the receiving channel been surveyed, and is there sufficient lateral displacement (tidal movement) to negate a density flow in the far-field?

Because these flows tend to have greater density than the surrounding ambient waters, they are negatively buoyant and will sink towards the bottom. After bottom boundary interaction (or stratified terminal layer formation) density current mixing is likely to occur.

Density current flows can extend for large distances in the far-field before transition to passive ambient diffusion.

<u>Care should be exercised when simulating these flows within CORMIX.</u>

Although the system does recognize negatively buoyant flow classes (NV, NH, MNU) <u>the system assumes a flat bottom topography.</u>

It is usually necessary to have access to cross-sectional diagrams of the water body. These should show the area normal to the ambient flow direction at the discharge site and at locations further downstream. These cross-sections should then be schematized into equivalent rectangular areas normal to the flow.

- If buoyancy-driven stratification of the effluent is likely, is hypoxia/anoxia in the bottom waters of the channel being investigated or proposed for monitoring?

CORMIX does not have any user-adjustable parameters. However, it is suggested that you run a sensitivity analysis with representing a range of discharge (velocity, density) and/or environmental conditions (depth, velocity, density stratification) likely to occur at your site.

- From Page 7, Figure 4, Amec, Foster& Wheeler, Process Design Basis and Narrative, Dec 2017

  The straight lines on the salinity graph between 11/1985 to 11/1988, and from 11/1997 to 11/2001 likely represent data gaps and should not be shown as connected (implying a continuous record). Were these data gaps included in the formulation of the 'average salinity level' used for the analysis?

- Because CORMIX Flow Class designation had such a large effect on the design outcome (% Above Ambient, Tables 7-10, Amec, Foster& Wheeler, Brine Discharge Mixing Analysis, Dec 2017), far more documentation of the Flow Classes under consideration is needed (more so than just Figure A.7.a, as provided in Appendix 3).

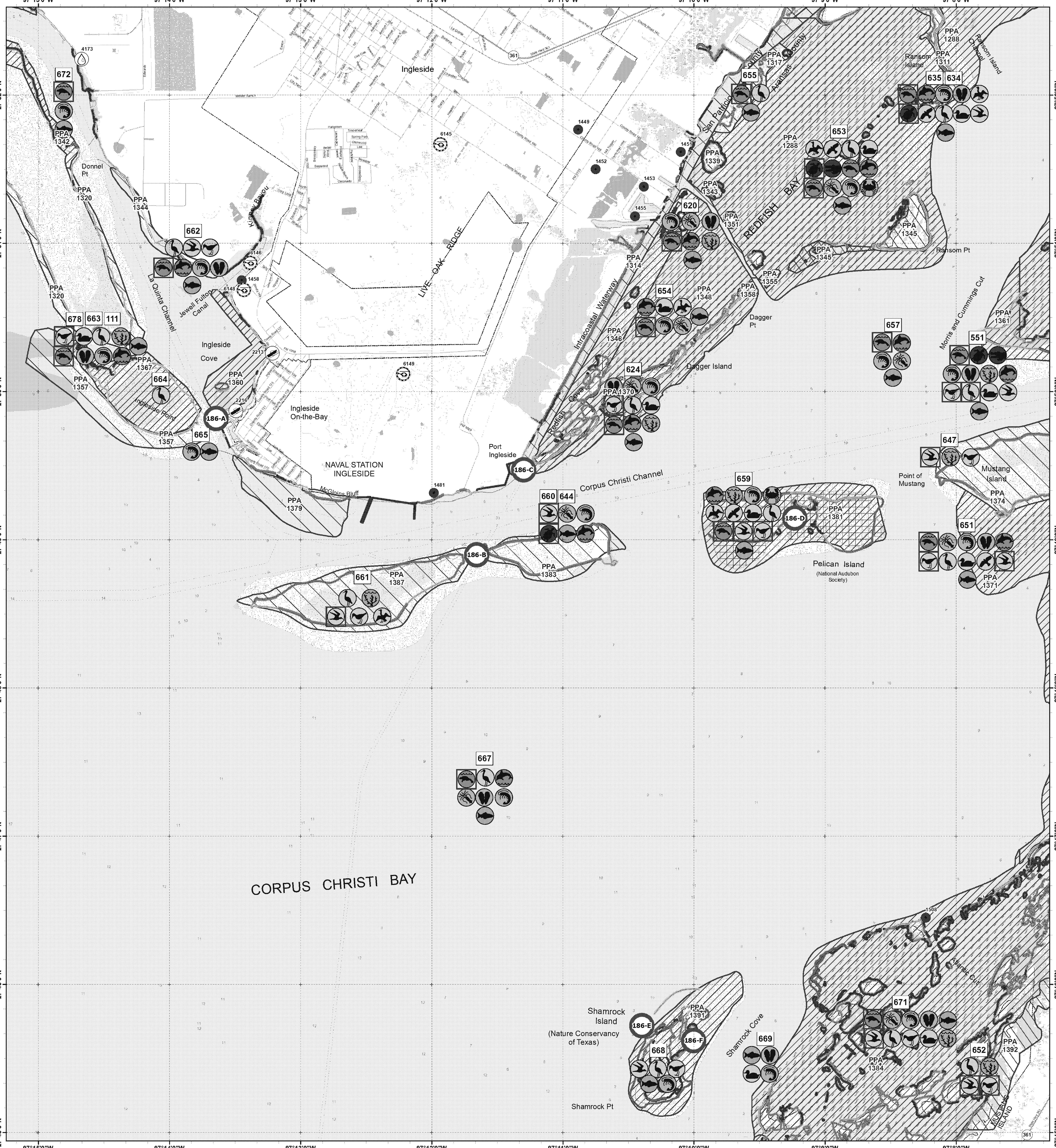
ATTACHMENT D

PORT INGLESIDE

(ARANSAS PASS, p.180)

Click Here or Scroll Down for Associated Map Data

Click on the Geographic Response Plan Target to View the ICS Form



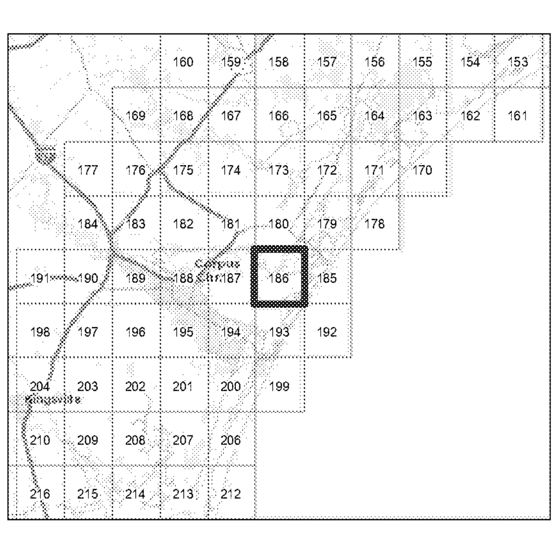
(PORTLAND, p.187)

(PORT ARANSAS, p.185)

(CRANE ISLANDS NW, p.193)

North Latitude

West Longitude



N

Miles 0 0.5 1

Nautical Miles 0 0.5 1

Feet 0 2,500 5,000

Kilometers 0 1 2

Depth Soundings in Feet

Oil Spill Planning and Response Atlas 2016

The Texas General Land Office makes no representations or warranties regarding the accuracy or completeness of the information depicted on this map or the data from which it was produced. This map is not suitable for navigational purposes and does not purport to depict boundaries of private and public land.

Human Use Features

- Boat Ramp
- Facility
- Heliport
- Water Intake
- Geographic Response Plan

Priority Protection Areas

- HIGH
- MEDIUM
- LOW

Map Base Layers

- State Highway
- Railroads
- Road
- GIWW
- Audubon Sanctuaries
- Oysters
- Estuarine Seagrass or Algae Bed
- Bays
- Salt and Brackish Marshes
- Beach or Tidal Flat
- Exposed Lake Shore
- Freshwater Marshes
- Willow Thickets
- Lake / Pond
- County Boundary
- City Limits

Species Icons Within Map Quad

- Alligator
- Turtle
- Turtle T/E
- Benthic Marine
- Bivalve
- Cephalopod
- Crab
- Shrimp
- Fish
- Fish T/E
- Dolphin
- Mammal
- Mammal T/E
- Marsh
- Diving Bird
- Gull/Tern
- Gull/Tern T/E
- Raptor
- Shorebird
- Shorebird Endangered
- Wading
- Wading Endangered
- Waterfowl

ENVIRONMENTAL SENSITIVITY INDEX

- 10D Mangroves and Woody Vegetation
- 10C Freshwater Swamps
- 10B Freshwater Marshes
- 10A Salt and Brackish Water Marshes
- 9 Sheltered Tidal Flats
- 8C Sheltered Rocky/Karst Shores
- 8D Sheltered Scarps
- 8B Sheltered Riprap Structures
- 8A Sheltered Solid Manmade Structures
- 7 Exposed Tidal Flats
- 6B Exposed Riprap Structures
- 6A Gravel or Shell Beaches
- 5 Mixed Sand and Gravel or Shell Beaches
- 4 Coarse-Grained Sand Beaches
- 3B Scraps and Steep Slopes in Sand
- 3A Fine-Grained Sand Beaches
- 2B Wave-Cut Clay Platforms
- 2A Scraps and Steep Slopes in Clay
- 1 Exposed Walls and Other Solid Structures

Quadrant: PORT INGLESIDE

Map # :186

Biological Information for this quadrant represents known concentration areas of occurrence.

Habitat Priority Protection Areas

PPA ID	PRIORITY	POLY DESC	BIRDS RANK	BIRDS DESC	FISH DESC	FISH RANK	WETLANDS R	WETLANDS D
	HIGH	GIWW Marker 51 Spoil colonial waterbird rookery, colony code 614-190	High	Great blue herons				
PPA1288	HIGH	Redfish Bay	HIGH	Waterfowl (pintails, redheads)	Important sport fishing and nursery area	HIGH	HIGH	Redfish Bay State Scientific Area,Extensive high-quality seagrass habitat (Halodule, Thalassia, other species)
PPA1311	MEDIUM	Ransom Island					MEDIUM	Redfish Bay State Scientific Area,High marsh grading into Spartina alterniflora with intertidal pools
PPA1314	LOW	Intracoastal Waterway			Fishing area, migration route, nursery, refuge in winter	MEDIUM	MEDIUM	Halodule fringe on west shore
PPA1317	LOW	Emilie Island	LOW	Rookery (614-180)			HIGH	Seagrass, Spartina fringe
PPA1320	LOW	Donnel Point spoil bank	MEDIUM				MEDIUM	Seagrass (Halodule)
PPA1339	LOW	Spoil island along ICW	LOW				HIGH	Redfish Bay State Scientific Area,Seagrass, Spartina fringe
PPA1342	HIGH	Donnel Point and shore from Donnel benchmark to Welder Point	MEDIUM	La Quinta Spoil Island colonial waterbird rookery (614-160)	Nursery	HIGH	MEDIUM	Seagrass (Halodule), Spartina fringe
PPA1343	MEDIUM	Spoil islands along cut to ICW					HIGH	
PPA1344	LOW	Donnel Point and shore from Donnel benchmark to Welder Point	MEDIUM				MEDIUM	Seagrass (Halodule), Spartina fringe
PPA1345	MEDIUM	Ransom Point and west of Ransom Point					HIGH	High marsh grading into Spartina alterniflora with intertidal pools
PPA1346	HIGH	Redfish Cove and spoil islands along Intracoastal Waterway	HIGH	Piping plover	Nursery	HIGH	HIGH	High marsh grading into Spartina alterniflora with intertidal pools; seagrass
PPA1348	HIGH	Redfish Bay	HIGH	Waterfowl (redhead, pintail, scaup, gadwall, mergansers), pelicans, osprey	Nursery area year-round for redfish, seatrout, shrimp, crabs, other species; heavy sport fishing	HIGH	HIGH	Redfish Bay State Scientific Area,Extensive seagrass flats (Halodule, Thalassia, some Syringodium); high marsh grading into Spartina fringe on islands
PPA1351	MEDIUM	Spoil islands along cut to ICW					HIGH	
PPA1355	HIGH	Dagger Point islands	HIGH	Piping plover				
PPA1357	LOW	Water west of Ingleside Point	MEDIUM		Fishing, some nursery habitat	MEDIUM		
PPA1358	HIGH	Dagger Point islands	HIGH	Piping plover				
PPA1360	HIGH	West and south shores of Ingleside-on-the-Bay			Productive nursery, recreational fishing	MEDIUM	MEDIUM	Seagrass (Halodule), Spartina fringe
PPA1361	HIGH	Southwest shore of West Harbor Island	HIGH	Least terns, piping plovers, shorebirds, peregrine falcons, red knots			LOW	Redfish Bay State Scientific Area,Shell bank, high marsh and sand flats
PPA1367	HIGH	Spoil banks north of Ingleside Point	MEDIUM	Ingleside Point colonial waterbird rookery, tern, skimmer rookery (614-182); plovers			MEDIUM	Seagrass (Halodule), Spartina fringe
PPA1370	HIGH	Dagger Island and islands in Redfish Cove	HIGH	Piping plover	Nursery	HIGH	HIGH	High marsh grading into Spartina alterniflora with intertidal pools
PPA1371	HIGH	Seagrass flats north and west of Coyote Island and East Flats	HIGH	Foraging area for wading birds, piping and snowy plovers, shorebirds, least terns in marsh and flats; waterfowl (redhead, pintail, scaup, ruddy duck) in grass flats; ospreys	Important nursery, fishing for red drum, other species; scattered oysters	HIGH	HIGH	Seagrass flats (Halodule, Thalassia and other species)
PPA1374	LOW	Point of Mustang spoil compartment		Least tern-skimmer rookery (614-183)				
PPA1379	LOW	West and south shores of Ingleside-on-the-Bay		Piping plover	Nursery	MEDIUM	MEDIUM	Seagrass (Halodule), Spartina fringe
PPA1381	HIGH	Pelican Island	VERY HIGH	One of largest colonial waterbird rookeries in Texas (614-184) with large numbers of brown pelicans, egrets, spoonbills, herons, laughing gulls, skimmers; seasonal use by piping plover, other shorebirds, peregrine falcon				Patches of Halodule, Spartina on south, northeast sides of island
PPA1383	LOW	Spoil islands south of Corpus Christi Channel	LOW	TCWS rookery (614-185); plovers, shorebirds, wading birds				
PPA1384	HIGH	Flats, marshes on west shore of Mustang Island	HIGH		Important nursery	HIGH	HIGH	Mud flats, low salt marsh (Spartina, Salicornia, Batis)

Back To Map

PPA ID	PRIORITY	POLY DESC	BIRDS RANK	BIRDS DESC	FISH DESC	FISH RANK	WETLANDS R	WETLANDS D
PPA1387	LOW	Spoil islands south of Corpus Christi Channel	LOW	TCWS rookery site (614-185)				
PPA1391	HIGH	Shamrock Island	VERY HIGH	Important colonial waterbird rookery (614-186) for reddish egret, spoonbills, other wading birds, terns, gulls; waterfowl, shorebird use, piping plover	Very important nursery for redfish, shrimp, other species; recreational fishing, scattered oysters	HIGH	HIGH	Brackish marsh (Borrichia, Salicornia, Suaeda, saltcedar)
PPA1392	MEDIUM	Flats, marshes on west shore of Mustang Island						

Biological Resources

Bird

RARNUM	NAME	S	F	CONC	J	F	M	A	M	J	J	A	S	O	N	D	NESTING	LAYING	HATCHING	FLEDGING
551	Terns				X	X	X	X	X	X	X	X	X	X	X	X				
	Shorebirds				X	X	X	X	X	X	X	X	X	X	X	X				
	Red knot		T					X	X			X	X							
	Piping plover		T		X	X	X	X	X		X	X	X	X	X	X				
	Wading birds				X	X	X	X	X	X	X	X	X	X	X	X	MAR-JUL	MAR-JUL	MAR-JUL	MAR-AUG
	Whooping crane		E		X	X	X	X						X	X	X				
	Waterfowl			HIGH	X	X	X	X	X	X	X	X	X	X	X	X				
624	Shorebirds				X	X	X	X	X	X	X	X	X	X	X	X				
	Ruddy turnstone				X	X	X	X	X				X	X	X	X				
	Sanderling				X	X	X	X	X			X	X	X	X	X				
	Red knot		T					X	X			X	X							
	Piping plover		T		X	X	X	X	X		X	X	X	X	X	X				
	Wading birds				X	X	X	X	X	X	X	X	X	X	X	X	MAR-JUL	MAR-JUL	MAR-JUL	MAR-AUG
	Great blue heron			6	X	X	X	X	X	X	X	X	X	X	X	X	DEC-MAR	JAN-MAR	FEB-APR	MAR-MAY
	Reddish egret				X	X	X	X	X	X	X	X	X	X	X	X	FEB-AUG	APR-AUG	APR-AUG	APR-SEP
	Waterfowl				X	X	X	X	X	X	X	X	X	X	X	X				
	Northern pintail	C			X	X	X	X				X	X	X	X	X				
	Redhead			HIGH	X	X	X	X	X					X	X	X				
634	Black skimmer	C			X	X	X	X	X	X	X	X	X	X	X	X	APR-SEP	APR-SEP	APR-SEP	APR-SEP
	Wading Birds				X	X	X	X	X	X	X	X	X	X	X	X	MAR-JUL	MAR-JUL	MAR-JUL	MAR-AUG
635	Brown pelican			HIGH	X	X	X	X	X	X	X	X	X	X	X	X	APR-SEP	APR-AUG	APR-AUG	APR-AUG
	Osprey				X	X	X	X	X	X	X	X	X	X	X	X				
	Reddish egret				X	X	X	X	X	X	X	X	X	X	X	X	FEB-AUG	APR-AUG	APR-AUG	APR-SEP
	Waterfowl				X	X	X	X	X	X	X	X	X	X	X	X				
	Northern pintail	C			X	X	X	X				X	X	X	X	X				
	American wigeon				X	X	X	X						X	X	X				
	Gadwall				X	X	X	X					X	X	X	X				
	Lesser scaup				X	X	X	X					X	X	X	X				
	Redhead				X	X	X	X	X					X	X	X				
	Red-breasted merganser				X	X	X	X							X	X				
639	Wading birds				X	X	X	X	X	X	X	X	X	X	X	X	MAR-JUL	MAR-JUL	MAR-JUL	MAR-AUG
	Redhead				X	X	X	X	X					X	X	X				
644	Least tern		E				X	X	X	X	X	X	X	X			APR–SEP	APR–SEP	MAY–SEP	MAY–SEP
647	Least tern		E				X	X	X	X	X	X	X	X			APR–SEP	APR–SEP	MAY–SEP	MAY–SEP
	Snowy plover				X	X	X	X	X	X	X	X	X	X	X	X	FEB–AUG	FEB–AUG	FEB–AUG	MAR–SEP
	Wilson's plover	C					X	X	X	X	X	X	X	X			MAR-AUG			
651	Least tern		E				X	X	X	X	X	X	X	X			APR–SEP	APR–SEP	MAY–SEP	MAY–SEP
	Osprey				X	X	X	X	X	X	X	X	X	X	X	X				
	Shorebirds				X	X	X	X	X	X	X	X	X	X	X	X				
	Red knot		T					X	X			X	X							
	Piping plover		T		X	X	X	X	X		X	X	X	X	X	X				
	Wilson's plover	C					X	X	X	X	X	X	X	X			MAR-AUG			
	American avocet				X	X	X	X	X			X	X	X	X	X				
	Wading birds				X	X	X	X	X	X	X	X	X	X	X	X	MAR-JUL	MAR-JUL	MAR-JUL	MAR-AUG
	Reddish egret				X	X	X	X	X	X	X	X	X	X	X	X	FEB-AUG	APR-AUG	APR-AUG	APR-SEP
	Northern pintail	C			X	X	X	X				X	X	X	X	X				
	Northern shoveler				X	X	X	X	X				X	X	X	X				
	Lesser scaup				X	X	X	X					X	X	X	X				
	Redhead				X	X	X	X	X					X	X	X				
	Ruddy duck				X	X	X	X						X	X	X				
652	Least tern		E				X	X	X	X	X	X	X	X			APR–SEP	APR–SEP	MAY–SEP	MAY–SEP
	Shorebirds				X	X	X	X	X	X	X	X	X	X	X	X				
	Red knot		T					X	X			X	X							
	Snowy plover				X	X	X	X	X	X	X	X	X	X	X	X	FEB–AUG	FEB–AUG	FEB–AUG	MAR–SEP
	Piping plover		T		X	X	X	X	X		X	X	X	X	X	X				
	Wilson's plover	C					X	X	X	X	X	X	X	X			MAR-AUG			
	American avocet				X	X	X	X	X			X	X	X	X	X				
	Wading birds				X	X	X	X	X	X	X	X	X	X	X	X	MAR-JUL	MAR-JUL	MAR-JUL	MAR-AUG
	Roseate spoonbill				X	X	X	X	X	X	X	X	X	X	X	X	APR-AUG	APR-AUG	APR-AUG	MAY-SEP
653	Brown pelican			HIGH	X	X	X	X	X	X	X	X	X	X	X	X	APR-SEP	APR-AUG	APR-AUG	APR-AUG
	Osprey				X	X	X	X	X	X	X	X	X	X	X	X				
	Wading birds				X	X	X	X	X	X	X	X	X	X	X	X	MAR-JUL	MAR-JUL	MAR-JUL	MAR-AUG
	Reddish egret				X	X	X	X	X	X	X	X	X	X	X	X	FEB-AUG	APR-AUG	APR-AUG	APR-SEP
	Waterfowl				X	X	X	X	X	X	X	X	X	X	X	X				
	Northern pintail	C			X	X	X	X				X	X	X	X	X				
	American wigeon				X	X	X	X						X	X	X				
	Lesser scaup				X	X	X	X					X	X	X	X				
	Redhead				X	X	X	X	X					X	X	X				
	Mergansers				X	X	X	X						X	X	X				
654	Brown pelican				X	X	X	X	X	X	X	X	X	X	X	X	APR-SEP	APR-AUG	APR-AUG	APR-AUG
	Waterfowl				X	X	X	X	X	X	X	X	X	X	X	X				
	Northern pintail	C			X	X	X	X				X	X	X	X	X				
	Lesser scaup				X	X	X	X					X	X	X	X				
	Redhead				X	X	X	X	X					X	X	X				
	Mergansers				X	X	X	X						X	X	X				
655	Wading birds				X	X	X	X	X	X	X	X	X	X	X	X	MAR-JUL	MAR-JUL	MAR-JUL	MAR-AUG
659	Brown pelican				X	X	X	X	X	X	X	X	X	X	X	X	APR-SEP	APR-AUG	APR-AUG	APR-AUG
	Terns				X	X	X	X	X	X	X	X	X	X	X	X				
	Laughing gull			VERY HIGH	X	X	X	X	X	X	X	X	X	X	X	X	FEB-AUG	FEB-AUG	FEB-AUG	MAR-SEP
	Black skimmer	C			X	X	X	X	X	X	X	X	X	X	X	X	APR-SEP	APR-SEP	APR-SEP	APR-SEP

Bird

RARNUM	NAME	S	F	CONC	J	F	M	A	M	J	J	A	S	O	N	D	NESTING	LAYING	HATCHING	FLEDGING
	Least tern		E				X	X	X	X	X	X	X	X			APR–SEP	APR–SEP	MAY–SEP	MAY–SEP
	Caspian tern				X	X	X	X	X	X	X	X	X	X	X	X	MAR-JUN	MAR-JUN	MAR-JUN	MAR-JUL
	Royal tern				X	X	X	X	X	X	X	X	X	X	X	X	FEB-AUG	FEB-AUG	FEB-AUG	MAR-SEP
	Gull-billed tern				X	X	X	X	X	X	X	X	X	X	X	X	FEB–AUG	FEB–AUG	FEB–AUG	MAR–SEP
	Sandwich tern				X	X	X	X	X	X	X	X	X	X	X	X	FEB-AUG	FEB-AUG	FEB-AUG	MAR-SEP
	Peregrine falcon				X	X	X	X	X				X	X	X	X				
	Shorebirds				X	X	X	X	X	X	X	X	X	X	X	X				
	Red knot		T					X	X			X	X							
	Snowy plover				X	X	X	X	X	X	X	X	X	X	X	X	FEB–AUG	FEB–AUG	FEB–AUG	MAR–SEP
	Piping plover		T		X	X	X	X	X		X	X	X	X	X					
	Wilson's plover	C					X	X	X	X	X	X	X	X			MAR-AUG			
	Black-crowned night-heron				X	X	X	X	X	X	X	X	X	X	X	X	APR-AUG	APR-AUG	APR-AUG	APR-SEP
	Wading birds				X	X	X	X	X	X	X	X	X	X	X	X	MAR-JUL	MAR-JUL	MAR-JUL	MAR-AUG
	Roseate spoonbill			20	X	X	X	X	X	X	X	X	X	X	X	X	APR-AUG	APR-AUG	APR-AUG	MAY-SEP
	Great blue heron			28	X	X	X	X	X	X	X	X	X	X	X	X	DEC-MAR	JAN-MAR	FEB-APR	MAR-MAY
	Cattle egret			26	X	X	X	X	X	X	X	X	X	X	X	X	APR-JUL	APR-JUL	APR-JUL	APR-AUG
	Great egret			16	X	X	X	X	X	X	X	X	X	X	X	X	DEC-MAR	JAN-MAR	FEB-APR	MAR-MAY
	Little blue heron				X	X	X	X	X	X	X	X	X	X	X	X	APR–JUL	APR–JUL	APR–JUL	MAY–AUG
	Reddish egret				X	X	X	X	X	X	X	X	X	X	X	X	FEB-AUG	APR-AUG	APR-AUG	APR-SEP
	Tricolored heron	C		2	X	X	X	X	X	X	X	X	X	X	X	X	APR-AUG	APR-AUG	APR-AUG	MAY-SEP
	White ibis			40	X	X	X	X	X	X	X	X	X	X	X	X	FEB-JUN	FEB-JUN	FEB-JUN	MAR-JUL
	White-faced ibis				X	X	X	X	X	X	X	X	X	X	X	X	FEB-AUG	FEB-AUG	FEB-AUG	MAR-SEP
	Mottled duck	C			X	X	X	X	X	X	X	X	X	X	X	X	JAN–AUG	JAN–AUG	JAN–AUG	FEB–SEP
660	Black skimmer	C			X	X	X	X	X	X	X	X	X	X	X	X	APR-SEP	APR-SEP	APR-SEP	APR-SEP
	Forster's tern				X	X	X	X	X	X	X	X	X	X	X	X	MAR-AUG	MAR-AUG	MAR-AUG	MAR-SEP
	Gull-billed tern				X	X	X	X	X	X	X	X	X	X	X	X	FEB–AUG	FEB–AUG	FEB–AUG	MAR–SEP
661	Brown pelican				X	X	X	X	X	X	X	X	X	X	X	X	APR-SEP	APR-AUG	APR-AUG	APR-AUG
	Laughing gull				X	X	X	X	X	X	X	X	X	X	X	X	FEB-AUG	FEB-AUG	FEB-AUG	MAR-SEP
	Black skimmer	C			X	X	X	X	X	X	X	X	X	X	X	X	APR-SEP	APR-SEP	APR-SEP	APR-SEP
	Least tern		E	56			X	X	X	X	X	X	X	X			APR–SEP	APR–SEP	MAY–SEP	MAY–SEP
	Forster's tern				X	X	X	X	X	X	X	X	X	X	X	X	MAR-AUG	MAR-AUG	MAR-AUG	MAR-SEP
	Royal tern				X	X	X	X	X	X	X	X	X	X	X	X	FEB-AUG	FEB-AUG	FEB-AUG	MAR-SEP
	Gull-billed tern				X	X	X	X	X	X	X	X	X	X	X	X	FEB–AUG	FEB–AUG	FEB–AUG	MAR–SEP
	Sandwich tern				X	X	X	X	X	X	X	X	X	X	X	X	FEB-AUG	FEB-AUG	FEB-AUG	MAR-SEP
	Shorebirds				X	X	X	X	X	X	X	X	X	X	X	X				
	Black-crowned night-heron				X	X	X	X	X	X	X	X	X	X	X	X	APR-AUG	APR-AUG	APR-AUG	APR-SEP
	Wading birds				X	X	X	X	X	X	X	X	X	X	X	X	MAR-JUL	MAR-JUL	MAR-JUL	MAR-AUG
	Roseate spoonbill				X	X	X	X	X	X	X	X	X	X	X	X	APR-AUG	APR-AUG	APR-AUG	MAY-SEP
	Great blue heron			60	X	X	X	X	X	X	X	X	X	X	X	X	DEC-MAR	JAN-MAR	FEB-APR	MAR-MAY
	Cattle egret				X	X	X	X	X	X	X	X	X	X	X	X	APR-JUL	APR-JUL	APR-JUL	APR-AUG
	Great egret			2	X	X	X	X	X	X	X	X	X	X	X	X	DEC-MAR	JAN-MAR	FEB-APR	MAR-MAY
	Reddish egret				X	X	X	X	X	X	X	X	X	X	X	X	FEB-AUG	APR-AUG	APR-AUG	APR-SEP
	Tricolored heron	C			X	X	X	X	X	X	X	X	X	X	X	X	APR-AUG	APR-AUG	APR-AUG	MAY-SEP
	White ibis				X	X	X	X	X	X	X	X	X	X	X	X	FEB-JUN	FEB-JUN	FEB-JUN	MAR-JUL
	White-faced ibis				X	X	X	X	X	X	X	X	X	X	X	X	FEB-AUG	FEB-AUG	FEB-AUG	MAR-SEP
662	Laughing gull				X	X	X	X	X	X	X	X	X	X	X	X	FEB-AUG	FEB-AUG	FEB-AUG	MAR-SEP
	Gull-billed tern				X	X	X	X	X	X	X	X	X	X	X	X	FEB–AUG	FEB–AUG	FEB–AUG	MAR–SEP
	Shorebirds				X	X	X	X	X	X	X	X	X	X	X	X				
	Wading birds				X	X	X	X	X	X	X	X	X	X	X	X	MAR-JUL	MAR-JUL	MAR-JUL	MAR-AUG
663	Shorebirds				X	X	X	X	X	X	X	X	X	X	X	X				
	Red knot		T					X	X			X	X							
	Piping plover		T		X	X	X	X	X		X	X	X	X	X					
	American avocet				X	X	X	X	X			X	X	X	X	X				
	Wading birds				X	X	X	X	X	X	X	X	X	X	X	X	MAR-JUL	MAR-JUL	MAR-JUL	MAR-AUG
	Black-necked stilt				X	X	X	X	X	X	X	X	X	X	X	X	APR–SEP	APR–SEP	APR–SEP	APR–SEP
664	Great blue heron			2	X	X	X	X	X	X	X	X	X	X	X	X	DEC-MAR	JAN-MAR	FEB-APR	MAR-MAY
667	Wading birds				X	X	X	X	X	X	X	X	X	X	X	X	MAR-JUL	MAR-JUL	MAR-JUL	MAR-AUG
668	Laughing gull				X	X	X	X	X	X	X	X	X	X	X	X	FEB-AUG	FEB-AUG	FEB-AUG	MAR-SEP
	Black skimmer	C			X	X	X	X	X	X	X	X	X	X	X	X	APR-SEP	APR-SEP	APR-SEP	APR-SEP
	Caspian tern				X	X	X	X	X	X	X	X	X	X	X	X	MAR-JUN	MAR-JUN	MAR-JUN	MAR-JUL
	Forster's tern				X	X	X	X	X	X	X	X	X	X	X	X	MAR-AUG	MAR-AUG	MAR-AUG	MAR-SEP
	Royal tern				X	X	X	X	X	X	X	X	X	X	X	X	FEB-AUG	FEB-AUG	FEB-AUG	MAR-SEP
	Sandwich tern				X	X	X	X	X	X	X	X	X	X	X	X	FEB-AUG	FEB-AUG	FEB-AUG	MAR-SEP
	Yellow-crowned night-heron				X	X	X	X	X	X	X	X	X	X	X	X	APR–SEP	APR–SEP	APR–SEP	APR–SEP
	Black-crowned night-heron				X	X	X	X	X	X	X	X	X	X	X	X	APR-AUG	APR-AUG	APR-AUG	APR-SEP
	Wading birds				X	X	X	X	X	X	X	X	X	X	X	X	MAR-JUL	MAR-JUL	MAR-JUL	MAR-AUG
	Roseate spoonbill				X	X	X	X	X	X	X	X	X	X	X	X	APR-AUG	APR-AUG	APR-AUG	MAY-SEP
	Cattle egret				X	X	X	X	X	X	X	X	X	X	X	X	APR-JUL	APR-JUL	APR-JUL	APR-AUG
	Little blue heron				X	X	X	X	X	X	X	X	X	X	X	X	APR–JUL	APR–JUL	APR–JUL	MAY–AUG
	Reddish egret				X	X	X	X	X	X	X	X	X	X	X	X	FEB-AUG	APR-AUG	APR-AUG	APR-SEP
	Tricolored heron	C			X	X	X	X	X	X	X	X	X	X	X	X	APR-AUG	APR-AUG	APR-AUG	MAY-SEP
	White ibis				X	X	X	X	X	X	X	X	X	X	X	X	FEB-JUN	FEB-JUN	FEB-JUN	MAR-JUL
	White-faced ibis				X	X	X	X	X	X	X	X	X	X	X	X	FEB-AUG	FEB-AUG	FEB-AUG	MAR-SEP
669	Waterfowl				X	X	X	X	X	X	X	X	X	X	X	X				
	Northern pintail	C			X	X	X	X				X	X	X	X	X				
	Redhead				X	X	X	X	X					X	X	X				
	American white pelican	C			X	X	X	X	X	X	X	X	X	X	X	X	FEB–AUG	FEB–AUG	FEB–AUG	MAR–SEP
671	Laughing gull				X	X	X	X	X	X	X	X	X	X	X	X	FEB-AUG	FEB-AUG	FEB-AUG	MAR-SEP
	Least tern		E				X	X	X	X	X	X	X	X			APR–SEP	APR–SEP	MAY–SEP	MAY–SEP
	Forster's tern				X	X	X	X	X	X	X	X	X	X	X	X	MAR-AUG	MAR-AUG	MAR-AUG	MAR-SEP
	Shorebirds				X	X	X	X	X	X	X	X	X	X	X	X				
	Wading birds				X	X	X	X	X	X	X	X	X	X	X	X	APR-JUL	APR-JUL	APR-JUL	MAY-AUG
	Reddish egret				X	X	X	X	X	X	X	X	X	X	X	X	FEB-AUG	APR-AUG	APR-AUG	APR-SEP
	Tricolored heron	C			X	X	X	X	X	X	X	X	X	X	X	X	APR-AUG	APR-AUG	APR-AUG	MAY-SEP
	White ibis				X	X	X	X	X	X	X	X	X	X	X	X	FEB-JUN	FEB-JUN	FEB-JUN	MAR-JUL
	Northern pintail	C			X	X	X	X				X	X	X	X	X				
	Northern shoveler				X	X	X	X	X				X	X	X	X				
	Lesser scaup				X	X	X	X					X	X	X	X				
	Redhead				X	X	X	X	X					X	X	X				
678	Rails				X	X	X	X	X	X	X	X	X	X	X	X				

Bird

RARNUM	NAME	S	F	CONC	J	F	M	A	M	J	J	A	S	O	N	D	NESTING	LAYING	HATCHING	FLEDGING
	Teals				X	X	X	X					X	X	X	X				
	Gadwall			HIGH	X	X	X	X					X	X	X	X				

Fish

RARNUM	NAME	S	F	CONC	J	F	M	A	M	J	J	A	S	O	N	D	LARV/JUV	SPAWNING
551	Native fish community				X	X	X	X	X	X	X	X	X	X	X	X		
	Gafftopsail catfish				X	X	X	X	X	X	X	X	X	X	X	X	MAY-SEP	MAY-AUG
620	Native fish community				X	X	X	X	X	X	X	X	X	X	X	X		
	Sheepshead				X	X	X	X	X	X	X	X	X	X	X	X	JAN-MAY	FEB-APR
	Gafftopsail catfish				X	X	X	X	X	X	X	X	X	X	X	X	MAY-SEP	MAY-AUG
	Gulf flounder				X	X	X	X	X	X	X	X	X	X	X	X		
	Atlantic bumper				X	X	X	X	X	X	X	X	X	X	X	X		
624	Native fish community				X	X	X	X	X	X	X	X	X	X	X	X		
	Gafftopsail catfish				X	X	X	X	X	X	X	X	X	X	X	X	MAY-SEP	MAY-AUG
	Silver perch				X	X	X	X	X	X	X	X	X	X	X	X	ALLYEAR	APR-SEP
634	Native fish community				X	X	X	X	X	X	X	X	X	X	X	X		
635	Native fish community				X	X	X	X	X	X	X	X	X	X	X	X		
639	Native fish community				X	X	X	X	X	X	X	X	X	X	X	X		
	Black drum				X	X	X	X	X	X	X	X	X	X	X	X	ALLYEAR	DEC-MAY
	Silver jenny				X	X	X	X	X	X	X	X	X	X	X	X		APR-AUG
644	Native fish community				X	X	X	X	X	X	X	X	X	X	X	X		
	Sheepshead				X	X	X	X	X	X	X	X	X	X	X	X	JAN-MAY	FEB-APR
	Gafftopsail catfish				X	X	X	X	X	X	X	X	X	X	X	X	MAY-SEP	MAY-AUG
	Gray snapper				X	X	X	X	X	X	X	X	X	X	X	X	APR-NOV	JUN-SEP
	Gulf butterfish				X	X	X	X	X	X	X	X	X	X	X	X	ALLYEAR	
651	Native fish community				X	X	X	X	X	X	X	X	X	X	X	X		
	Sheepshead				X	X	X	X	X	X	X	X	X	X	X	X	JAN-MAY	FEB-APR
	Pipefish				X	X	X	X	X	X	X	X	X	X	X	X		
	Atlantic stingray				X	X	X	X	X	X	X	X	X	X	X	X		DEC-APR
	Atlantic spadefish				X	X	X	X	X	X	X	X	X	X	X	X		MAY-SEP
	Cownose ray				X	X	X	X	X	X	X	X	X	X	X	X		
653	Native fish community				X	X	X	X	X	X	X	X	X	X	X	X		
	Gafftopsail catfish				X	X	X	X	X	X	X	X	X	X	X	X	MAY-SEP	MAY-AUG
	Black drum				X	X	X	X	X	X	X	X	X	X	X	X	ALLYEAR	DEC-MAY
	Spotfin mojarra				X	X	X	X	X	X	X	X	X	X	X	X		
654	Native fish community				X	X	X	X	X	X	X	X	X	X	X	X		
	Gafftopsail catfish				X	X	X	X	X	X	X	X	X	X	X	X	MAY-SEP	MAY-AUG
	Black drum				X	X	X	X	X	X	X	X	X	X	X	X	ALLYEAR	DEC-MAY
	Silver perch				X	X	X	X	X	X	X	X	X	X	X	X	ALLYEAR	APR-SEP
	Spotfin mojarra				X	X	X	X	X	X	X	X	X	X	X	X		
657	Native fish community				X	X	X	X	X	X	X	X	X	X	X	X		
	Gafftopsail catfish				X	X	X	X	X	X	X	X	X	X	X	X	MAY-SEP	MAY-AUG
	Silver perch				X	X	X	X	X	X	X	X	X	X	X	X	ALLYEAR	APR-SEP
	Atlantic bumper				X	X	X	X	X	X	X	X	X	X	X	X		
659	Native fish community				X	X	X	X	X	X	X	X	X	X	X	X		
	Gafftopsail catfish				X	X	X	X	X	X	X	X	X	X	X	X	MAY-SEP	MAY-AUG
	Ladyfish							X	X	X	X	X	X	X				SEP-OCT
	Black drum				X	X	X	X	X	X	X	X	X	X	X	X	ALLYEAR	DEC-MAY
662	Native fish community				X	X	X	X	X	X	X	X	X	X	X	X		
	Gafftopsail catfish				X	X	X	X	X	X	X	X	X	X	X	X	MAY-SEP	MAY-AUG
663	Native fish community				X	X	X	X	X	X	X	X	X	X	X	X		
	Gafftopsail catfish				X	X	X	X	X	X	X	X	X	X	X	X	MAY-SEP	MAY-AUG
	Silver perch				X	X	X	X	X	X	X	X	X	X	X	X	ALLYEAR	APR-SEP
665	Native fish community				X	X	X	X	X	X	X	X	X	X	X	X		
	Gafftopsail catfish				X	X	X	X	X	X	X	X	X	X	X	X	MAY-SEP	MAY-AUG
667	Native fish community				X	X	X	X	X	X	X	X	X	X	X	X		
	Sharks				X	X	X	X	X	X	X	X	X	X	X	X		
	Sheepshead				X	X	X	X	X	X	X	X	X	X	X	X	JAN-MAY	FEB-APR
	Gafftopsail catfish				X	X	X	X	X	X	X	X	X	X	X	X	MAY-SEP	MAY-AUG
	Black drum				X	X	X	X	X	X	X	X	X	X	X	X	ALLYEAR	DEC-MAY
	Silver perch				X	X	X	X	X	X	X	X	X	X	X	X	ALLYEAR	APR-SEP
	Atlantic needlefish				X	X	X	X	X	X	X	X	X	X	X	X		JUN-AUG
668	Native fish community				X	X	X	X	X	X	X	X	X	X	X	X		
	Sheepshead				X	X	X	X	X	X	X	X	X	X	X	X	JAN-MAY	FEB-APR
	Gafftopsail catfish				X	X	X	X	X	X	X	X	X	X	X	X	MAY-SEP	MAY-AUG
	Silver perch				X	X	X	X	X	X	X	X	X	X	X	X	ALLYEAR	APR-SEP
669	Native fish community				X	X	X	X	X	X	X	X	X	X	X	X		
	Sheepshead				X	X	X	X	X	X	X	X	X	X	X	X	JAN-MAY	FEB-APR
	Gafftopsail catfish				X	X	X	X	X	X	X	X	X	X	X	X	MAY-SEP	MAY-AUG
	Black drum				X	X	X	X	X	X	X	X	X	X	X	X	ALLYEAR	DEC-MAY
671	Native fish community				X	X	X	X	X	X	X	X	X	X	X	X		
	Gafftopsail catfish				X	X	X	X	X	X	X	X	X	X	X	X	MAY-SEP	MAY-AUG
	Black drum				X	X	X	X	X	X	X	X	X	X	X	X	ALLYEAR	DEC-MAY
	Silver perch				X	X	X	X	X	X	X	X	X	X	X	X	ALLYEAR	APR-SEP
	Spotfin mojarra				X	X	X	X	X	X	X	X	X	X	X	X		
	Silver jenny				X	X	X	X	X	X	X	X	X	X	X	X		APR-AUG
	Cownose ray				X	X	X	X	X	X	X	X	X	X	X	X		
672	Native fish community				X	X	X	X	X	X	X	X	X	X	X	X		
	Black drum				X	X	X	X	X	X	X	X	X	X	X	X	ALLYEAR	DEC-MAY
678	Native fish community				X	X	X	X	X	X	X	X	X	X	X	X		
	Gafftopsail catfish				X	X	X	X	X	X	X	X	X	X	X	X	MAY-SEP	MAY-AUG

Invertebrate

RARNUM	NAME	S	F	CONC	J	F	M	A	M	J	J	A	S	O	N	D	LARV/JUV	SPAWNING
111	Eastern oyster				X	X	X	X	X	X	X	X	X	X	X	X	MAY-JAN	MAR-NOV

Invertebrate

RARNUM	NAME	S	F	CONC	J	F	M	A	M	J	J	A	S	O	N	D	LARV/JUV	SPAWNING
551	Eastern oyster				X	X	X	X	X	X	X	X	X	X	X	X	MAY-JAN	MAR-NOV
	Native shrimp and crab community				X	X	X	X	X	X	X	X	X	X	X	X		
620	Eastern oyster				X	X	X	X	X	X	X	X	X	X	X	X	MAY-JAN	MAR-NOV
	Native shrimp and crab community				X	X	X	X	X	X	X	X	X	X	X	X		
624	Eastern oyster				X	X	X	X	X	X	X	X	X	X	X	X	MAY-JAN	MAR-NOV
	Atlantic brief squid				X	X	X	X	X	X	X	X	X	X	X	X		
	Native shrimp and crab community				X	X	X	X	X	X	X	X	X	X	X	X		
634	Eastern oyster				X	X	X	X	X	X	X	X	X	X	X	X	MAY-JAN	MAR-NOV
	Native shrimp and crab community				X	X	X	X	X	X	X	X	X	X	X	X		
635	Native shrimp and crab community				X	X	X	X	X	X	X	X	X	X	X	X		
639	Eastern oyster				X	X	X	X	X	X	X	X	X	X	X	X	MAY-JAN	MAR-NOV
	Native shrimp and crab community				X	X	X	X	X	X	X	X	X	X	X	X		
644	Atlantic brief squid				X	X	X	X	X	X	X	X	X	X	X	X		
	Native shrimp and crab community				X	X	X	X	X	X	X	X	X	X	X	X		
651	Eastern oyster			LOW	X	X	X	X	X	X	X	X	X	X	X	X	MAY-JAN	MAR-NOV
	Quahog (hard clam)				X	X	X	X	X	X	X	X	X	X	X	X		JUN-DEC
	Native shrimp and crab community				X	X	X	X	X	X	X	X	X	X	X	X		
653	Hermit crabs				X	X	X	X	X	X	X	X	X	X	X	X		
	Gulf grassflat crab				X	X	X	X	X	X	X	X	X	X	X	X		
	Native shrimp and crab community				X	X	X	X	X	X	X	X	X	X	X	X		
654	Native shrimp and crab community				X	X	X	X	X	X	X	X	X	X	X	X		
657	Atlantic brief squid				X	X	X	X	X	X	X	X	X	X	X	X		
	Native shrimp and crab community				X	X	X	X	X	X	X	X	X	X	X	X		
659	Hermit crabs				X	X	X	X	X	X	X	X	X	X	X	X		
	Native shrimp and crab community				X	X	X	X	X	X	X	X	X	X	X	X		
662	Eastern oyster			LOW	X	X	X	X	X	X	X	X	X	X	X	X	MAY-JAN	MAR-NOV
	Native shrimp and crab community				X	X	X	X	X	X	X	X	X	X	X	X		
663	Native shrimp and crab community				X	X	X	X	X	X	X	X	X	X	X	X		
665	Native shrimp and crab community				X	X	X	X	X	X	X	X	X	X	X	X		
667	Dwarf surf clam				X	X	X	X	X	X	X	X	X	X	X	X		MAY-NOV
	Cnidarians				X	X	X	X	X	X	X	X	X	X	X	X		
	Polychaetes				X	X	X	X	X	X	X	X	X	X	X	X		
	Atlantic brief squid				X	X	X	X	X	X	X	X	X	X	X	X		
	Native shrimp and crab community				X	X	X	X	X	X	X	X	X	X	X	X		
668	Native shrimp and crab community				X	X	X	X	X	X	X	X	X	X	X	X		
669	Eastern oyster				X	X	X	X	X	X	X	X	X	X	X	X	MAY-JAN	MAR-NOV
	Native shrimp and crab community				X	X	X	X	X	X	X	X	X	X	X	X		
671	Eastern oyster			LOW	X	X	X	X	X	X	X	X	X	X	X	X	MAY-JAN	MAR-NOV
	Native shrimp and crab community				X	X	X	X	X	X	X	X	X	X	X	X		
672	Native shrimp and crab community				X	X	X	X	X	X	X	X	X	X	X	X		
678	Native shrimp and crab community				X	X	X	X	X	X	X	X	X	X	X	X		

Marine Mammal

RARNUM	NAME	S	F	CONC	J	F	M	A	M	J	J	A	S	O	N	D	LARV/JUV	SPAWNING	MATING	CALVING
551	Bottlenose dolphin				X	X	X	X	X	X	X	X	X	X	X	X	MAR-MAY	JUL-AUG	JAN-DEC	JAN-DEC
	West Indian manatee		E	LOW			X	X	X	X	X	X	X	X	X					
620	Bottlenose dolphin				X	X	X	X	X	X	X	X	X	X	X	X	MAR-MAY	JUL-AUG	JAN-DEC	JAN-DEC
	West Indian manatee		E	LOW			X	X	X	X	X	X	X	X	X					
624	Bottlenose dolphin				X	X	X	X	X	X	X	X	X	X	X	X	MAR-MAY	JUL-AUG	JAN-DEC	JAN-DEC
	West Indian manatee		E	LOW			X	X	X	X	X	X	X	X	X					
634	Bottlenose dolphin				X	X	X	X	X	X	X	X	X	X	X	X	MAR-MAY	JUL-AUG	JAN-DEC	JAN-DEC
	West Indian manatee		E	LOW			X	X	X	X	X	X	X	X	X					
635	Bottlenose dolphin				X	X	X	X	X	X	X	X	X	X	X	X	MAR-MAY	JUL-AUG	JAN-DEC	JAN-DEC
	West Indian manatee		E	LOW			X	X	X	X	X	X	X	X	X					
639	Bottlenose dolphin				X	X	X	X	X	X	X	X	X	X	X	X	MAR-MAY	JUL-AUG	JAN-DEC	JAN-DEC
	West Indian manatee		E	LOW			X	X	X	X	X	X	X	X	X					
644	Bottlenose dolphin				X	X	X	X	X	X	X	X	X	X	X	X	MAR-MAY	JUL-AUG	JAN-DEC	JAN-DEC
651	Bottlenose dolphin				X	X	X	X	X	X	X	X	X	X	X	X	MAR-MAY	JUL-AUG	JAN-DEC	JAN-DEC
	West Indian manatee		E	LOW			X	X	X	X	X	X	X	X	X					
653	Bottlenose dolphin				X	X	X	X	X	X	X	X	X	X	X	X	MAR-MAY	JUL-AUG	JAN-DEC	JAN-DEC
	West Indian manatee		E	LOW			X	X	X	X	X	X	X	X	X					
	River otter	C			X	X	X	X	X	X	X	X	X	X	X	X				
654	Bottlenose dolphin				X	X	X	X	X	X	X	X	X	X	X	X	MAR-MAY	JUL-AUG	JAN-DEC	JAN-DEC
	West Indian manatee		E	LOW			X	X	X	X	X	X	X	X	X					
655	West Indian manatee		E	LOW			X	X	X	X	X	X	X	X	X					
657	Bottlenose dolphin				X	X	X	X	X	X	X	X	X	X	X	X	MAR-MAY	JUL-AUG	JAN-DEC	JAN-DEC

Marine Mammal

RARNUM	NAME	S	F	CONC	J	F	M	A	M	J	J	A	S	O	N	D	LARV/JUV	SPAWNING	MATING	CALVING
	West Indian manatee		E	LOW			X	X	X	X	X	X	X	X	X					
659	Bottlenose dolphin				X	X	X	X	X	X	X	X	X	X	X	X	MAR-MAY	JUL-AUG	JAN-DEC	JAN-DEC
	West Indian manatee		E	LOW			X	X	X	X	X	X	X	X	X					
662	Bottlenose dolphin				X	X	X	X	X	X	X	X	X	X	X	X	MAR-MAY	JUL-AUG	JAN-DEC	JAN-DEC
	West Indian manatee		E	LOW			X	X	X	X	X	X	X	X	X					
663	Bottlenose dolphin				X	X	X	X	X	X	X	X	X	X	X	X	MAR-MAY	JUL-AUG	JAN-DEC	JAN-DEC
	West Indian manatee		E	LOW			X	X	X	X	X	X	X	X	X					
667	Bottlenose dolphin				X	X	X	X	X	X	X	X	X	X	X	X	MAR-MAY	JUL-AUG	JAN-DEC	JAN-DEC
	West Indian manatee		E	LOW			X	X	X	X	X	X	X	X	X					
671	West Indian manatee		E	LOW			X	X	X	X	X	X	X	X	X					
672	West Indian manatee		E	LOW			X	X	X	X	X	X	X	X	X					
678	Bottlenose dolphin				X	X	X	X	X	X	X	X	X	X	X	X	MAR-MAY	JUL-AUG	JAN-DEC	JAN-DEC
	West Indian manatee		E	LOW			X	X	X	X	X	X	X	X	X					

Reptile

RARNUM	NAME	S	F	CONC	J	F	M	A	M	J	J	A	S	O	N	D	NESTING	LAYING	HATCHING	LARV/JUV
551	American alligator				X	X	X	X	X	X	X	X	X	X	X	X	JUN–SEP	JUN–DEC	JUN–DEC	ALLYEAR
	Texas diamondback terrapin	C			X	X	X	X	X	X	X	X	X	X	X	X	MAY-JUL	MAY-JUL	APR-AUG	
635	Loggerhead sea turtle		T		X	X	X	X	X	X	X	X	X	X	X	X	APR-AUG		MAY-OCT	ALLYEAR
	Green sea turtle		T		X	X	X	X	X	X	X	X	X	X	X	X	APR-AUG		MAY-OCT	ALLYEAR
	Leatherback sea turtle		E	LOW	X	X	X	X	X	X	X	X	X	X	X	X				ALLYEAR
	Atlantic hawksbill sea turtle		E	LOW				X	X	X	X	X	X	X						APR–OCT
	Kemp's ridley sea turtle		E		X	X	X	X	X	X	X	X	X	X	X	X	APR-AUG		MAY-OCT	ALLYEAR
644	Loggerhead sea turtle		T	LOW	X	X	X	X	X	X	X	X	X	X	X	X	APR-AUG		MAY-OCT	ALLYEAR
	Green sea turtle		T	LOW	X	X	X	X	X	X	X	X	X	X	X	X	APR-AUG		MAY-OCT	ALLYEAR
	Kemp's ridley sea turtle		E		X	X	X	X	X	X	X	X	X	X	X	X	APR-AUG		MAY-OCT	ALLYEAR
653	American alligator				X	X	X	X	X	X	X	X	X	X	X	X	JUN–SEP	JUN–DEC	JUN–DEC	ALLYEAR
	Green sea turtle		T		X	X	X	X	X	X	X	X	X	X	X	X	APR-AUG		MAY-OCT	ALLYEAR

Human Use Resources

Boat Ramp	RARNUM	NAME	CONTACT	CONTACT INFO
	2213	Ingleside Cove Boat Ramp		sanpatricionueces@inglesidecove
	2216	Bahia Docks Store		sanpatricionueces@bahiadocks
Facility	**RARNUM**	**NAME**	**CONTACT**	**CONTACT INFO**
	1449	CINCO - ST 348	David Maresh	361-537-0210
	1451	Sunray Terminal, LLC.	Jeff Kirby	(361)882-5117
	1452	Phoenix Marine Terminal	Jeff Kirby	713-398-6695
	1453	State Service Co. Inc.	Richard McMakin	361-729-5630
	1455	Brown Water Marine Service	Chad Chapman	3613860039
	1458	Signet Maritime Corporation: Ingleside Division	Ray Johns	361-776-7500
	1481	FHR Ingleside Marine Terminal Facility	Valerie Pompa	361.816.3221
	1508	Shamrock Island Production Facility	William Sparks	(832) 435-4471 (Bill Sparks)
Heliport	**RARNUM**	**NAME**	**CONTACT**	**CONTACT INFO**
	6145	OAK RIDGE	4TA7	INGLESIDE, TX 78362
	6146	ARCO INGLESIDE SHOREBASE	0TA6	INGLESIDE, TX 78362
	6148	JBH AEROSPACE	10TX	INGLESIDE, TX 78362
	6149	NAVSTA INGLESIDE	TA09	INGLESIDE, TX 78362-5001
Water Intake	**RARNUM**	**NAME**	**CONTACT**	**CONTACT INFO**
	4173	E I DU PONT DE NEMOURS		

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1. Incident Name	2. Operational Period (Date/Time)	Assignment List ICS 204-OS

3. Branch	4. Division/Group

5. Operations Personnel
Operations Section Chief
Branch Director
Division/Group Supervisor

6. Resources Assigned This Period "X" Indicates 204a attachement with special instructions

Resource Identifier	Leader	Contact Info #	# of Persons	Reporting Info/Notes/Remarks

7. Assignments

SAFETY NOTE: High vessel traffic with dangerous wakes and surges possible. Slip, trip and fall hazard. Proper PPE is required.

8. Site Number:	9. Quad Name	10. NOAA Chart #	11. GLO Atlas Page #	12. County
186-A	Port Ingleside	11309	186	San Patricio

13. Site Information: 49E
Ingleside Cove contains salt and brackish marshes and a public boat ramp, as well as residential piers. Nearby spoil islands are a low priority skimmer and tern rookery. East side of pass is concrete bulkhead. West side is sandy beach. Before restricting traffic in LaQuinta Channel, contact Harbor Master at (361) 882-1773.

14. Latitude From: 27 49' 50" **To:**

15. Longitude From: 97 13' 42" **To:**

16. Closest Boat Ramp	17. Distance From Ramp	18. Boat Type
Ingleside Cove public ramp	0.6 NM	Medium to shallow draft work boats

19. Directions From Local Sector
Take Hwy 35 N over CC Harbor Bridge to Hwy 361 S toward Ingleside. In Ingleside, turn right onto FM 1069 S. Continue for 3.2 Miles. Ingleside Cove public ramp will be on the right.

20. Closest Airport
T.P McCampbell Airport

21. Closest Helo Spot
T.P McCampbell Airport

22. Trustee/Contact Numbers

USCG:	(361) 888-3162	RRC:	361-242-3113
USCG DUTY:	361-533-7166	TPWD:	(512)-389-4848
TGLO:	361-886-1650	NRDA:	(512) 463 -9309
TCEQ:	361-825-3100	USFWS:	361-994-9005

23. Resources at Risk
Atlas Priority Low
Environmental High
Economic High

24.Width of inlet in ft. 800'
25. Water depth in ft. 40-50'
26. Current
27. No. of Personnel 4-6

25. Booming Strategy Recommendation
Protection booming of pass. Current can be strong through pass. Secondary boom may be necessary depending on wind, tide, and current conditions.

AERIAL PHOTO

ON SITE PHOTO

29. Prepared By:	30. Reviewed by (PSC)	31. Reviewed by (OSC):
Assignment List	ICS 204 OS (Geographic Response Plan)	Project Updated:

"Response strategies may need to be modified to account for changes due to seasonality, weather conditions, spill characteristics, tides and any other considerations."

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Operations Section Chief

Branch Director

Division/Group Supervisor

6. Resources Assigned This Period "X" Indicates 204a attachement with special instructions

Resource Identifier	Leader	Contact Info #	# of Persons	Reporting Info/Notes/Remarks	

7. Assignments

SAFETY NOTE: High vessel traffic with dangerous wakes and surges possible. Slip, trip and fall hazard. Proper PPE is required.

8. Site Number:	9. Quad Name	10. NOAA Chart #	11. GLO Atlas Page #	12. County
186-B	Port Ingleside	11309	186	San Patricio

13. Site Information: 49F

The spoil islands themselves are not high priority, but booming the pass between them could prevent oil from escaping into Corpus Christi Bay or vice versa. Western spoil island is sandy beach with steep scarps on its' eastern side. Spoil island to the East is sandy beaches. Before restricting traffic in federally maintained waterway, contact Harbor Master at (361) 882-1773.

14. Latitude From: 27 48' 54" **To:**

15. Longitude From: 97 11' 40" **To:**

16. Closest Boat Ramp	17. Distance From Ramp	18. Boat Type
Ingleside Cove public ramp	3.0 NM	Medium to shallow draft workboats

19. Directions From Local Sector

Take Hwy 35 N over CC Harbor Bridge to Hwy 361 S toward Ingleside. In Ingleside, turn right onto FM 1069 S. Continue for 3.2 Miles. Ingleside Cove public ramp will be on the right.

20. Closest Airport

T.P McCampbell Airport

21. Closest Helo Spot

T.P McCampbell Airport

22. Trustee/Contact Numbers

USCG:	(361) 888-3162	RRC:	361-242-3113
USCG DUTY:	361-533-7166	TPWD:	(512)-389-4848
TGLO:	361-886-1650	NRDA:	(512) 463 -9309
TCEQ:	361-825-3100	USFWS:	361-994-9005

23. Resources at Risk

Atlas Priority	Low
Environmental	Low
Economic	High

24.Width of inlet in ft. 1100'

25. Water depth in ft. 8-15'

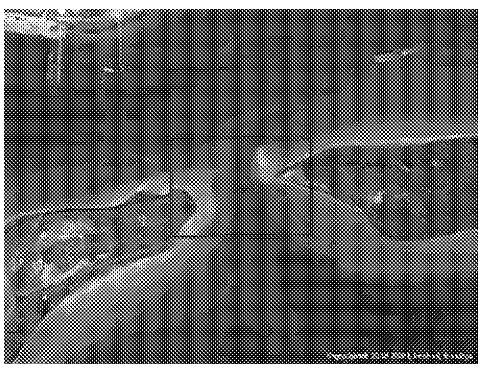
26. Current potentially strong

27. No. of Personnel 4-6

25. Booming Strategy Recommendation

Protection booming of pass. Current can be strong through pass. Secondary boom may be necessary depending on wind, tide, and current conditions.

AERIAL PHOTO



ON SITE PHOTO

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Assignment List	ICS 204 OS (Geographic Response Plan)	Project Updated:

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Operations Section Chief

Branch Director

Division/Group Supervisor

6. Resources Assigned This Period "X" Indicates 204a attachement with special instructions

Resource Identifier	Leader	Contact Info #	# of Persons	Reporting Info/Notes/Remarks	

7. Assignments

SAFETY NOTE: High vessel traffic with dangerous wakes and surges possible. Slip, trip and fall hazard. Proper PPE is required.

8. Site Number:	9. Quad Name	10. NOAA Chart #	11. GLO Atlas Page #	12. County
186-C	Port Ingleside	11309	186	San Patricio

13. Site Information: 49G

Location is in Corpus Christi Bay. This pass is where the Intracoastal Waterway meets the Corpus Christi Channel. Booming here could protect several sensitive areas, depending on wind and current conditions. Before restricting traffic in federally maintained waterway, contact Harbor Master at (361) 882-1773.

14. Latitude From: 27 49' 32" **To:**

15. Longitude From: 97 11' 16" **To:**

16. Closest Boat Ramp
Ingleside Cove public boat ramp

17. Distance From Ramp
3.5 NM

18. Boat Type
Medium to Shallow draft work boats

19. Directions From Local Sector
Take Hwy 35 N over CC Harbor Bridge to Hwy 361 S toward Ingleside. In Ingleside, turn right onto FM 1069 S. Continue for 3.2 Miles. Ingleside Cove public ramp will be on the right.

20. Closest Airport
T.P McCampbell Airport

21. Closest Helo Spot
T.P McCampbell Airport

22. Trustee/Contact Numbers

USCG:	(361) 888-3162	RRC:	361-242-3113
USCG DUTY:	361-533-7166	TPWD:	(512)-389-4848
TGLO:	361-886-1650	NRDA:	(512) 463 -9309
TCEQ:	361-825-3100	USFWS:	361-994-9005

23. Resources at Risk

Atlas Priority	High
Environmental	High
Economic	High

24.Width of inlet in ft. 480

25. Water depth in ft. 8-15

26. Current Potentially strong

27. No. of Personnel 4-6

25. Booming Strategy Recommendation

Protection booming of pass. Current can be strong through pass. Secondary boom may be necessary depending on wind, tide, and current conditions.

AERIAL PHOTO

ON SITE PHOTO

29. Prepared By:	30. Reviewed by (PSC)	31. Reviewed by (OSC):
Assignment List	ICS 204 OS (Geographic Response Plan)	Project Updated:

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Operations Section Chief

Branch Director

Division/Group Supervisor

6. Resources Assigned This Period "X" Indicates 204a attachement with special instructions

Resource Identifier	Leader	Contact Info #	# of Persons	Reporting Info/Notes/Remarks	

7. Assignments

SAFETY NOTE: High vessel traffic with dangerous wakes and surges possible. Slip, trip and fall hazard. Proper PPE is required.

8. Site Number:	9. Quad Name	10. NOAA Chart #	11. GLO Atlas Page #	12. County
186-D	Port Ingleside	11309	186	San Patricio

13. Site Information: 186-D

Pelican Island. Location is in Corpus Christi Bay. Pelican Island is a National Audobon Society bird sanctuary site. Most of island is sand beach, but the South side has a shallow bay that extends approximately 0.3 miles into island and contains sheltered tidal flats and brackish marsh. Posted with "Do Not Land" signs.

14. Latitude From: 27 49' 2" **To:**

15. Longitude From: 97 9' 12" **To:**

16. Closest Boat Ramp	17. Distance From Ramp	18. Boat Type
Ingleside Cove public ramp	5.2 NM	Medium to Shallow draft work boats

19. Directions From Local Sector

Take Hwy 35 N over CC Harbor Bridge to Hwy 361 S toward Ingleside. In Ingleside, turn right onto FM 1069 S. Continue for 3.2 Miles. Ingleside Cove public ramp will be on the right.

20. Closest Airport

T.P McCampbell Airport

21. Closest Helo Spot

T.P McCampbell Airport

22. Trustee/Contact Numbers

USCG:	(361) 888-3162	RRC:	361-242-3113
USCG DUTY:	361-533-7166	TPWD:	(512)-389-4848
TGLO:	361-886-1650	NRDA:	(512) 463 -9309
TCEQ:	361-825-3100	USFWS:	361-994-9005

23. Resources at Risk

Atlas Priority	High
Environmental	High
Economic	High

24.Width of inlet in ft. 1800'

25. Water depth in ft. 1-4'

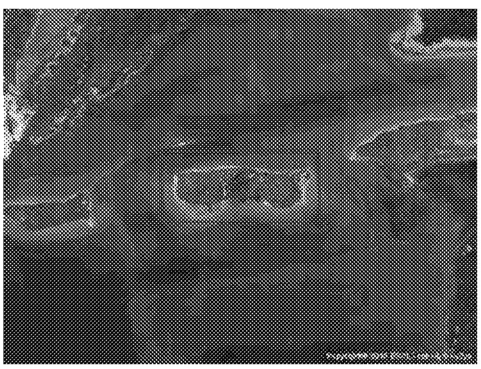
26. Current

27. No. of Personnel 4-6

25. Booming Strategy Recommendation

Protection booming of pass. Current can be strong through pass. Secondary boom may be necessary depending on wind, tide, and current conditions.

AERIAL PHOTO



ON SITE PHOTO

29. Prepared By:	30. Reviewed by (PSC)	31. Reviewed by (OSC):
Assignment List	ICS 204 OS (Geographic Response Plan)	Project Updated:

"Response strategies may need to be modified to account for changes due to seasonality, weather conditions, spill characteristics, tides and any other considerations."

1. Incident Name	2. Operational Period (Date/Time)	Assignment List ICS 204-OS
3. Branch	4. Division/Group	

5. Operations Personnel
Operations Section Chief
Branch Director
Division/Group Supervisor

6. Resources Assigned This Period "X" Indicates 204a attachement with special instructions

Resource Identifier	Leader	Contact Info #	# of Persons	Reporting Info/Notes/Remarks

7. Assignments

SAFETY NOTE: Numerous natural gas and condensate pipelines populate the island area. Some of these pipelines may be partially exposed due to wind and wave action. Snakes may be present (including venomous rattlesnakes.) stingrays also inhabit the shallow waters near the island. Proper PPE required.

8. Site Number:	9. Quad Name	10. NOAA Chart #	11. GLO Atlas Page #	12. County
186-E	Port Ingleside	11311,11312	186	Nueces

13. Site Information: 186-E
Location is on the west bank of Shamrock Island, in Corpus Christi Bay. These are several natural cuts into the interior of Shamrock Island. Site encompasses fringe marsh including Smooth Cordgrass and Black Mangrove. Primary booming should be placed to protect along Shamrock Island in front of primary and secondary sloughs. Water access only. Contact Nature Conservancy: Mark Dumesnil (361)-882-3584.

14. Latitude From: 27 45' 45.4" To:
15. Longitude From: 97 10' 12.8" To:

16. Closest Boat Ramp	17. Distance From Ramp	18. Boat Type
Wilson's Cut	2.6 NM	Shallow Draft work boats

19. Directions From Local Sector
Drive east on TX 358. Continue on TX P22 east for 5.9 miles. Turn left onto TX 361. Travel 9.24 miles north. Turn left at dirt road entrance to Wilson's Cut. Ramp is directly across from the Mustang and Sandpiper condominiums. Island is approximately 1 mile NW of Wilson's Cut.

20. Closest Airport
Mustang beach Airport, Port A.

21. Closest Helo Spot

22. Trustee/Contact Numbers

USCG:	(361) 888-3162	RRC:	361-242-3113
USCG DUTY:	361-533-7166	TPWD:	(512)-389-4848
TGLO:	361-886-1650	NRDA:	(512) 463 -9309
TCEQ:	361-825-3100	USFWS:	361-994-9005

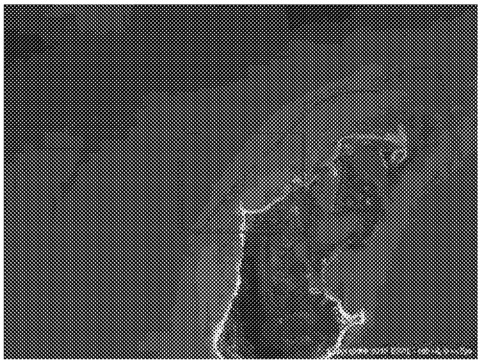
23. Resources at Risk

Atlas Priority	High
Environmental	High
Economic	High

24.Width of inlet in ft. 1700'
25. Water depth in ft. 1-4'
26. Current
27. No. of Personnel 6-8

25. Booming Strategy Recommendation
Exclusion booming of natural cuts between Corpus Christi Bay and the interior of Shamrock Island. The area of several cuts into the island extends for approx. 1700' in width. Secondary boom may be necessary depending on wind, tide, and current condition

AERIAL PHOTO



ON SITE PHOTO

29. Prepared By:	30. Reviewed by (PSC)	31. Reviewed by (OSC):
Assignment List	ICS 204 OS (Geographic Response Plan)	Project Updated:

"Response strategies may need to be modified to account for changes due to seasonality, weather conditions, spill characteristics, tides and any other considerations."

1. Incident Name	2. Operational Period (Date/Time)	Assignment List ICS 204-OS
3. Branch	4. Division/Group	

5. Operations Personnel

Operations Section Chief

Branch Director

Division/Group Supervisor

6. Resources Assigned This Period "X" Indicates 204a attachement with special instructions

Resource Identifier	Leader	Contact Info #	# of Persons	Reporting Info/Notes/Remarks	

7. Assignments

SAFETY NOTE: Numerous natural gas and condensate pipelines populate the island area. Some of these pipelines may be partially exposed due to wind and wave action. Snakes may be present (including venomous rattlesnakes,) stingrays also inhabit the shallow waters near the island. Proper PPE required.

8. Site Number:	9. Quad Name	10. NOAA Chart #	11. GLO Atlas Page #	12. County
186-F	Port Ingleside	11311	186	Nueces

13. Site Information: 49B

Location is on the east bank of Shamrock Island, in Corpus Christi Bay. This is several natural cuts into the interior of Shamrock Island. Site encompasses fringe marsh including Smooth Cordgrass and Black Mangrove. Primary booming should be placed to protect along Shamrock Island in front of primary and secondary sloughs. Water access only. Contact Nature Conservancy: Mark Dumesnil (361)-882-3584.

14. Latitude From: 27 45' 36.4" To:

15. Longitude From: 97 9' 57.3" To:

16. Closest Boat Ramp	17. Distance From Ramp	18. Boat Type
Wilson's Cut (Unimproved)	2.6 NM	Shallow Draft work boats

19. Directions From Local Sector

Drive east on TX 358. Continue on TX P22 east for 5.9 miles. Turn left onto TX 361. Travel 9.24 miles north. Turn left at dirt road entrance to Wilson's Cut. Ramp is directly across from the Mustang and Sandpiper condominiums. Island is approximately 1 mile NW of Wilson's Cut.

20. Closest Airport

Mustang beach Airport, Port A.

21. Closest Helo Spot

22. Trustee/Contact Numbers

USCG:	(361) 888-3162	RRC:	361-242-3113
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TCEQ:	361-825-3100	USFWS:	361-994-9005

23. Resources at Risk

Atlas Priority	High
Environmental	High
Economic	High

24.Width of inlet in ft. 2500'

25. Water depth in ft. 1-4'

26. Current

27. No. of Personnel 6-8

25. Booming Strategy Recommendation

Exclusion booming of natural cuts between Corpus Christi Bay and the interior of Shamrock Island. The area of several cuts into the island extends for approx. 1700' in width. Secondary boom may be necessary depending on wind, tide, and current condition

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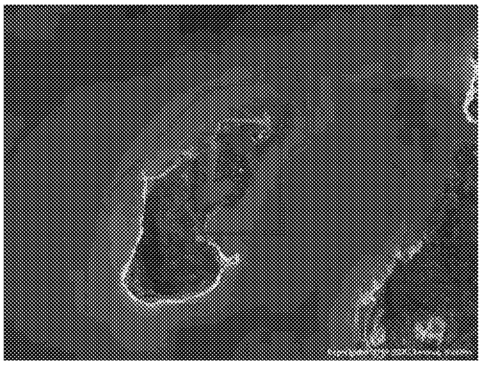

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